ITPE

Interactive Transit Pricing Evaluation Model

PREPARED BY

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Users Manual

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16. Abstract

The Interactive Transit Pricing Evaluation (ITPE) model is developed as a user-interactive pricing strategic planning system. Input and output features are menu-driven and graphical in nature to enhance user friendliness and ease of interaction. The ITPE model consists of three submodels: the disaggregate elasticity model for ridership and revenue (DELREV), a cost model, and a pricing policy evaluation model. DELREV defines the impacts of fare and service policy changes on various submarkets. Included in this submodel is an elasticity selector that helps the user select specific elasticities based on previously collected data. The cost model estimates the supply cost of transit provision in regards to specified variables, service types, and fare categories. The pricing policy evaluation model forecasts the impacts of the change in fares and/or service levels on the performance of the transit system as a whole.

The ITPE model has been tested using ridership data from the Queen City Metro in Cincinnati.

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INTRODUCTION

More now than ever before, transit managers have to improve their decision making effectiveness to cope with the issues of subsidies, rising operating costs, and declining ridership. In the field of pricing itself, with the growing shift from flat fares to differential fare structures in most transit properties, decision making is becoming more and more complex. Given a socio-political environment, pricing decisions are usually semi-structured and require judgement for the solution search. The issue is not just how much to increase fares, but also how to devise a balanced fare policy which improves the financial posture of the property while at the same time ensuring fairness to various groups of riders.

With this view, the Interactive Transit Pricing Evaluation (ITPE) model has been developed as a user interactive pricing and strategic planning system. To enhance user friendliness and ease of interaction with decision makers, all input and output features of the ITPE are kept graphical in nature. The hierarchical menu structure of this model allows great flexibility in model use and permits quick access and exit from a particular screen.

The ITPE model consists of three submodels: the disaggregate elasticity model for ridership and revenue forecasting (DELREV), a cost model and a pricing policy evaluation model. DELREV is the basic component of the entire system. It is a monthly ridership and fare revenue forecasting model which incorporates the effects of demographic changes, seasonality, inflation, change in auto cost of travel, time lag of fare and service change effects as well as the implications of ridership shifts between cash fare and prepayment fare categories. DELREV has been designed with the option of evaluating both existing and new prepayment fare plan(s). Using the notion of demand elasticities, DELREV forecasts for each user-defined submarket the impact of fare and service policies. In cases where elasticity value(s) for the desired level of

stratification is/are not available, an optional module called the elasticity selector can be accessed by the user. This module permits a user to view all compiled information on elasticity values in the form of graphical displays.

In order to estimate the supply cost of transit service, the cost model component permits development of up to eight cost models for user specified service categories using a maximum of seven allocation variables. This model provides the user almost instantaneous visualization of input data and resulting cost allocation models. For cost forecasting purposes, the model accepts cost escalation factors for each expense category throughout five future years.

The pricing policy evaluation component of the ITPE forecasts the impacts of fare and/or service change policies on the performance of the transit system as a whole as well as of individual fare or trip market segments. In addition to total ridership, revenue, cost per trip, and revenue per trip, two other measures of performance, revenue/cost ratio and Ramsey prices, are estimated and displayed. The revenue/cost ratio for the system as a whole and for each market segment reflects the equity aspect of a pricing policy. On the other hand, a comparison between the proposed (or existing) pricing structure and that of the estimated Ramsey prices displays the accepted level of departure between the proposed or existing pricing and an economically efficient pricing structure. For a realistic analysis, the model permits estimation of both constrained and unconstrained Ramsey prices. The subsidy feature permits a user to set his or her own constraints such as maximum fare limits by market segments and/or annual subsidy levels.

The ITPE model can be utilized for a maximum forecast period of five years and five modifications proposed to the base fare or service levels. The program is designed to run on any IBM PC, XT, AT or compatible computer with a minimum of 512K RAM. Since the program can produce output graphs to the screen or printer, a user may want a graphics monitor with compatible graphics card (CGA) or monochrome monitor with HERCULES graphics card.

The accuracy of model prediction is, of course, a function of the applicability of these techniques to the situation in question, and also depends to a great extent upon the accuracy of input parameter values. Therefore, care must be taken in gathering the appropriate data and correctly entering it into the system. The ITPE model has been tested using ridership data from Queen City Metro, Cincinnati.

CHAPTER 1: HOW TO USE THE ITPE PROGRAM

HARDWARE REQUIREMENTS:

The ITPE program is designed to run on any IBM PC, XT, AT or compatible computer. Your system should have at least:

- 512K RAM (640K for larger models)

- 2 floppy drives, or
  1 hard disk, or
  1 floppy drive & 640K (300K used for ramdisk)

- Monochrome monitor

HARDWARE OPTIONS:

The ITPE program produces output in the form of tables and graphs. If you wish to be able to output graphs to the screen or printer, then you will need:

- Graphics monitor with IBM CGA (or compatible graphics card)

or

Monochrome monitor with HERCULES graphics card (or compatible)

- Epson or compatible printer supporting the low resolution of 640 dots/line.

If you are using a HERCULES compatible card, then use the disk labeled 'HERCULES'.

INSTALLING THE ITPE PROGRAM USING TWO FLOPPY DRIVES:
(See APPENDIX A - ALTERNATIVE INSTALLATIONS)

1) Insert the ITPE disk in drive A:

2) Insert a blank formatted disk in drive B:
(This is to be your data disk)

3) TYPE: A: (then press RETURN)

4) TYPE: ITPE B: (then press RETURN)

GETTING STARTED:

You are now presented with the title screen. Pressing any key at this point will display the master ITPE menu which displays the following 4 options:

INPUT FARE/REV
INPUT COST
OUTPUT FARE/REV REPORTS
OUTPUT POLICY EVALUATION

Throughout the program, you are presented with menus to guide you through the various screens. All menus use the SPACE BAR to highlight the option and the RETURN key to execute it. Pressing the ESC key exits any screen.

The overall flow of the screens that make up the ITPE program is shown in FIGURES F1,F2, and F3 in CHAPTER 2: DESCRIPTIONS OF ITPE SCREENS. Also explained is how to use each screen.

WHAT TO DO NOW:

The general scheme of the ITPE program is to first input and edit 5 data input files, then choose the OUTPUT REPORTS option which will run the input data through the model and allow you to view the results.

The first thing to do now is to select the INPUT/FARE REV. option which will display another menu with 4 options:

FARE DATA INPUT
SERVICE DATA INPUT
AUTO COST OF TRAVEL INPUT
CONSUMER PRICE INDEX & NOMINAL GROWTH INPUT

Each of these options creates a data file which therefore result in 4 types of data files. These files are assigned the following filename extensions: .FRx, .SRx, .AUT, & .CPI. Input the data for the 4 data files.

You may wish to read APPENDIX B if you want a detailed explanation of how the ITPE program handles your data entry. Also APPENDIX C discusses the input files you will be creating.

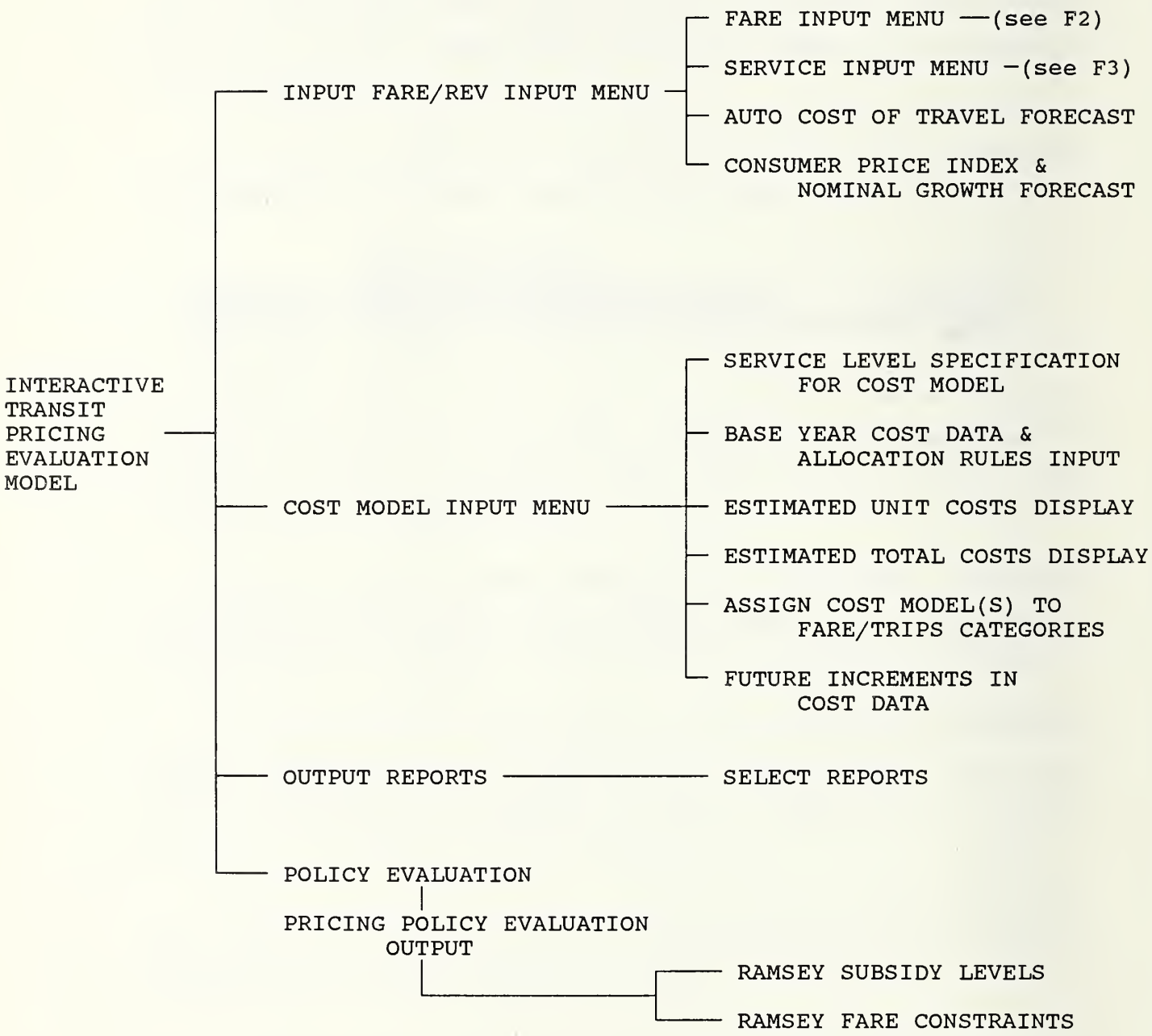
From the master ITPE menu, you can now choose the OUTPUT REPORTS option which will ask for the names of the 4 data files just described above (APPENDIX D explains about setting up many scenarios in order to compare results).

From the master ITPE menu, you can now also choose the INPUT COST option which will create the 5th type of data file which is assigned the filename extension '.CST'.

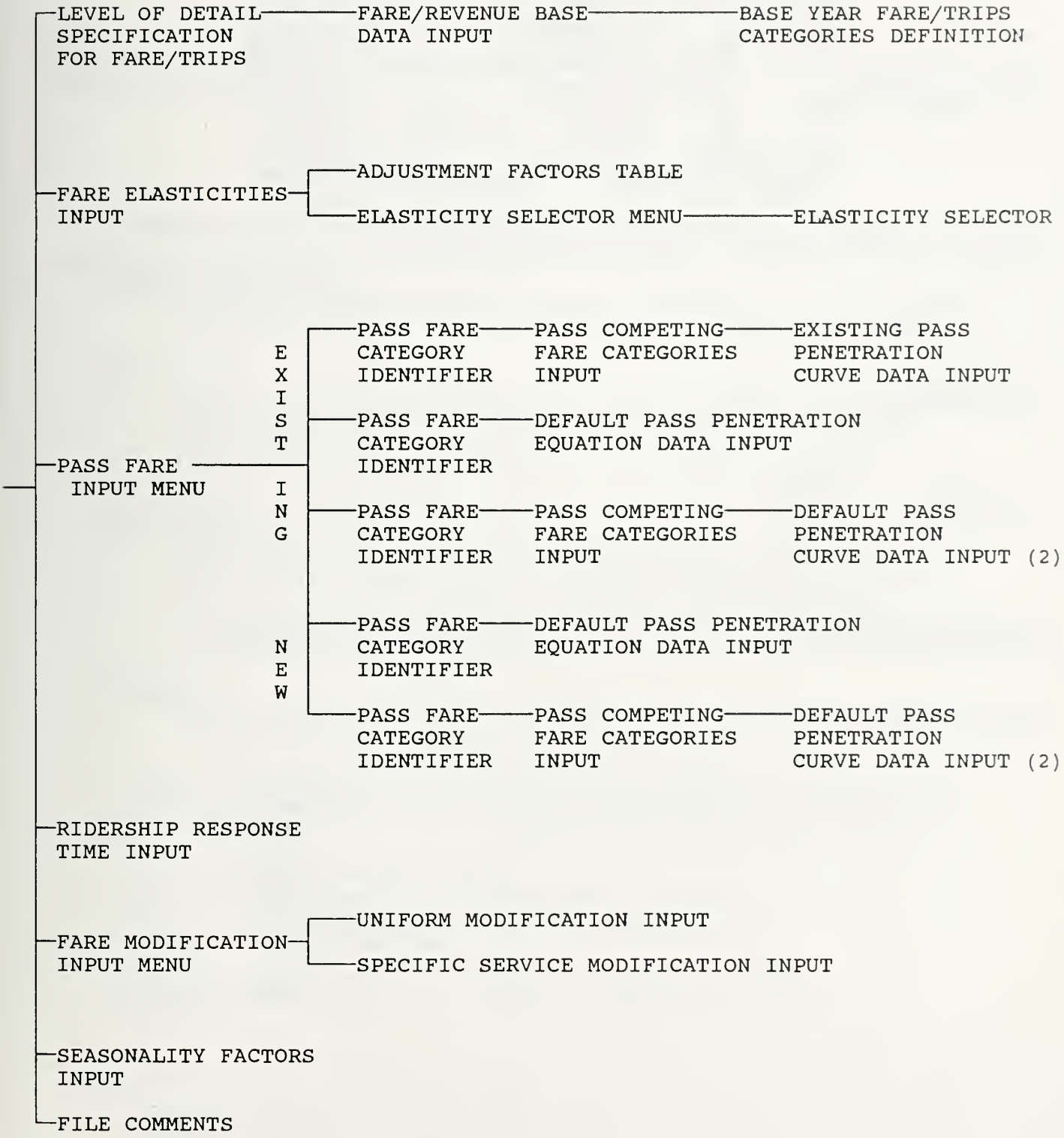
Finally, from the master ITPE menu, you can choose the OUTPUT POLICY EVALUATION option which reads in all 5 types of input data files.

CHAPTER 2: DESCRIPTION OF ITPE SCREENS

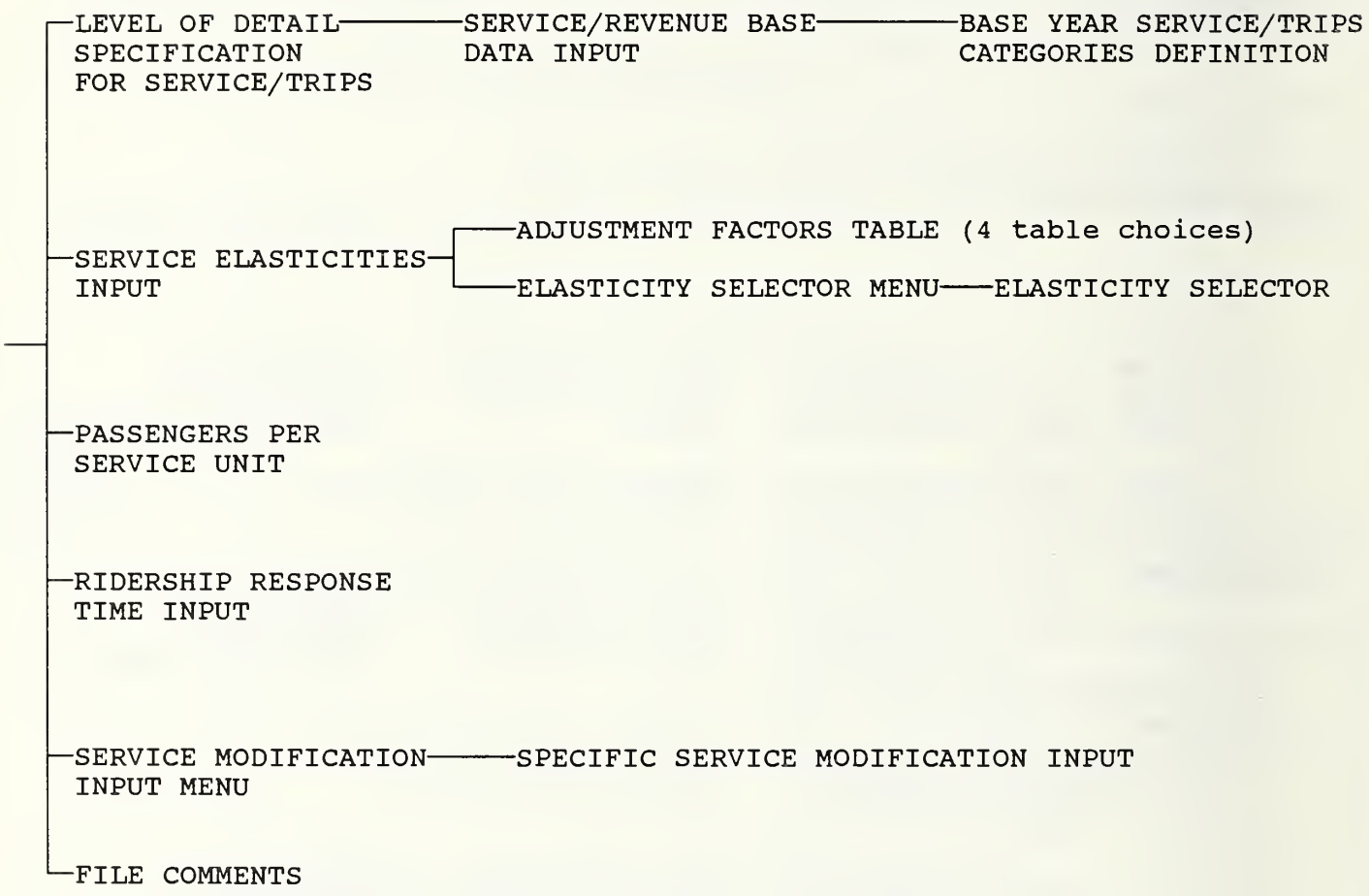
F1: SCREEN HIERARCHY OF RIDERSHIP/REVENUE MODEL BY TITLE

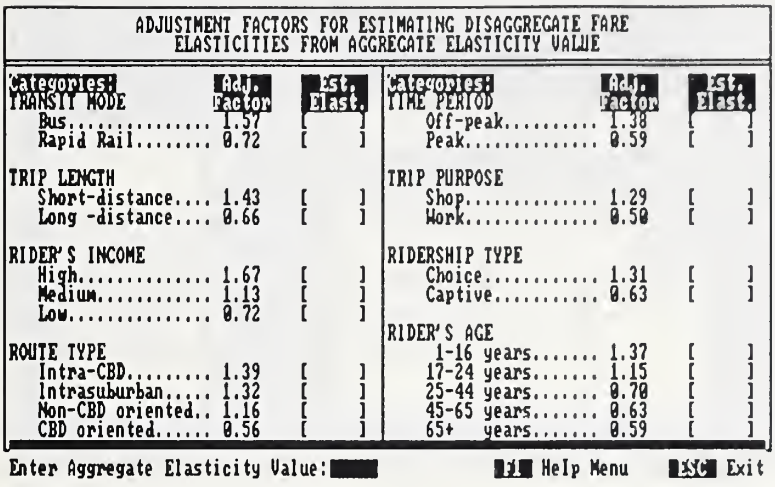


F2: SCREEN HIERARCHY OF FARE INPUT BY TITLE



F3: SCREEN HIERARCHY OF SERVICE INPUT BY TITLE





ADJUSTMENT FACTORS TABLE

SCREEN DESCRIPTION:

Adjustment factors table for the estimation of disaggregate elasticities to aid the user in selecting an elasticity.

WHAT TO DO:

Enter the aggregate elasticity value at the bottom of this table. The model will immediately multiply this input value with the displayed adjustment factors and show the estimated elasticity value for each market segment.

HOW TO DO:

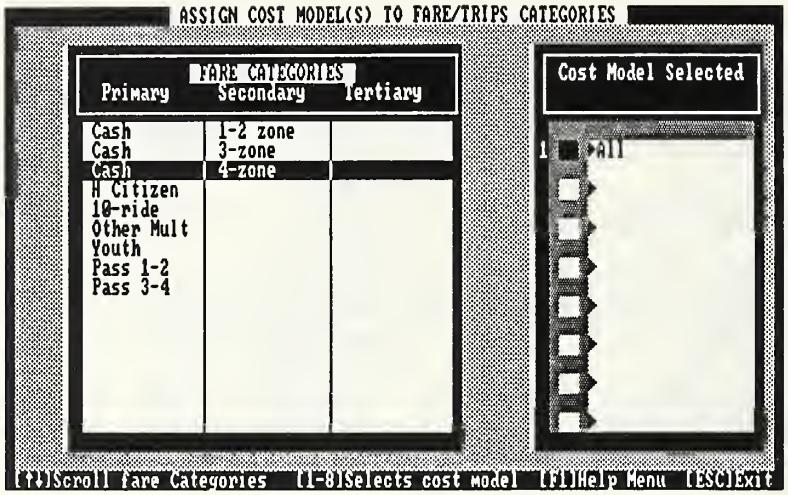
Type in an elasticity value less than 2.0, then press the RETURN key and the estimated elasticity will be calculated. You can now either enter a different value or press the ESC key to exit the table. Remember the calculated estimated elasticity value so that when you return back to the ELASTICITY INPUT screen, you can fill in the value.

COMMENTS:

The adjustment tables for SERVICE work in the same manner.

KEY	FUNCTION
RETURN	Formats the field entered and displays all estimated elasticity values using the aggregate value you had input.
F1	Shows the HELP MENU.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: (FARE or SERVICE) ELASTICITIES INPUT



ASSIGN COST MODEL(S) TO FARE/TRIPS CATEGORIES

SCREEN DESCRIPTION:

In the left window are the FARE CATEGORIES defined from the the INPUT FARE/REV screen which was stored in the ???????.FRx files.

WHAT TO DO:

Assign one service type on the right to a fare category on the left.

HOW TO DO:

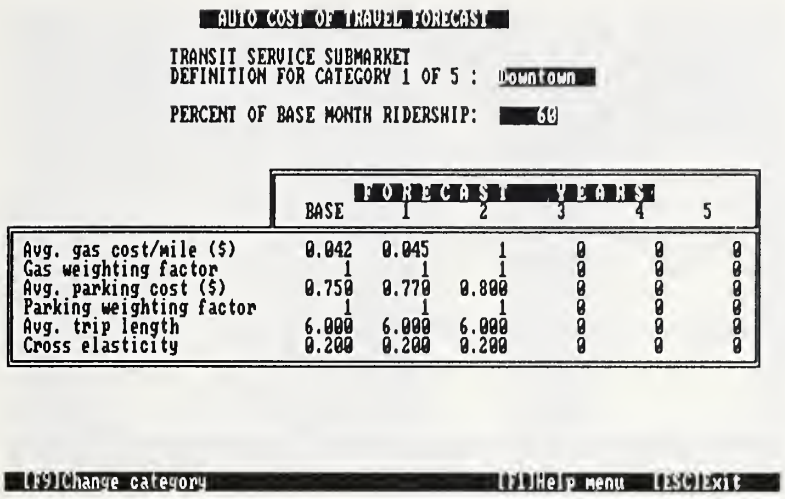
Use the UP or DOWN arrow key to move the highlight bar over a particular fare category, then press the 1,2,3,4,5,6,7, or 8 key. (The # key corresponding to the desired service type.)

COMMENTS:

NONE.

KEY	FUNCTION
UP,DOWN	Moves the cursor to another fare category.
1-8	Assigns that service type to the highlighted fare category. Only one service type can be selected.
ESC	Exit the screen.

PREVIOUS SCREEN: COST MODEL INPUT MENU



AUTO COST OF TRAVEL FORECAST

SCREEN DESCRIPTION:

Auto cost of travel forecast input for up to 5 years and for up to 5 submarkets.

WHAT TO DO:

Type in the values for up to 5 years forecasting and for up to 5 different transit service submarkets. Examples of potential submarkets are CBD, suburban-activity-center, etc. The percentage of base month trips belonging to the market group is then typed in below the submarket.

Variables:

a) Average gas cost per mile (in $).
b) Gas weighting factor used to assign more (greater than 1) or less (less than 1) importance to gasoline costs as related to auto use.
c) Average parking cost per day (in $).
d) Parking cost weighting factor used to assign importance of parking costs as related to auto use.
e) Average trip length of auto users within the user-defined transit service submarket.
f) Cross elasticity of the market group with respect to auto cost of travel.

HOW TO DO:

Use the arrow keys to move to the desired field, then type in the value. To enter data for a different submarket, press the F9 key. The current submarket being worked on is indicated where the submarket definition is entered. The definition is a text field.

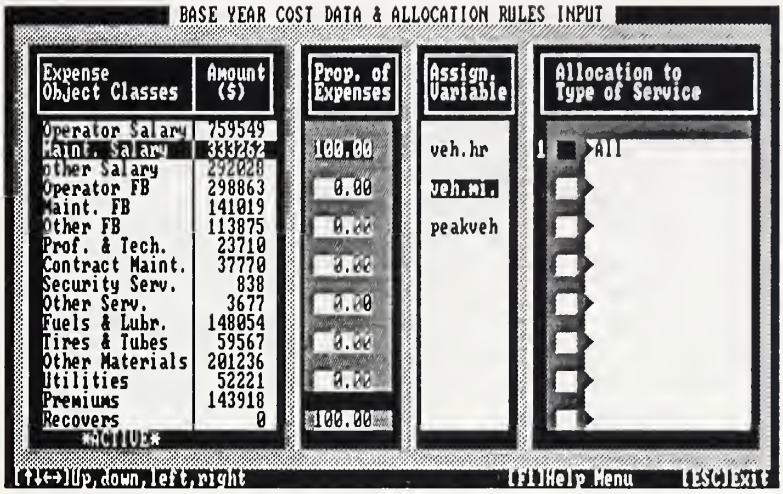
COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Switches screen entry to the next submarket.

RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
anytext	Valid input data for submarket definition field.
ESC	Exit the screen.

PREVIOUS SCREEN: INPUT FARE/REV MENU



BASE YEAR COST DATA & ALLOCATION RULES INPUT

SCREEN DESCRIPTION:

Base year cost data & allocation rules input.

WHAT TO DO:

Enter the EXPENSE OBJECT CLASS and AMOUNT. Then for each EXPENSE OBJECT CLASS, there can be a list of proportions (PROP. OF EXPENSES). And for each proportion, there is one ASSIGN. VARIABLE which can be allocated to MANY types of services.

HOW TO DO:

Use the arrow keys to move to the desired field. The LEFT and RIGHT arrow keys move the cursor left and right. The *ACTIVE* indicator at the bottom of the windows help you see what column the cursor is in. The UP and DOWN key moves the highlight bar UP and DOWN depending on which window the cursor is in.

The PROP. OF EXPENSES percentages pertain to the one highlighted EXPENSE OBJECT CLASS. The total proportion is displayed at the bottom of that window.

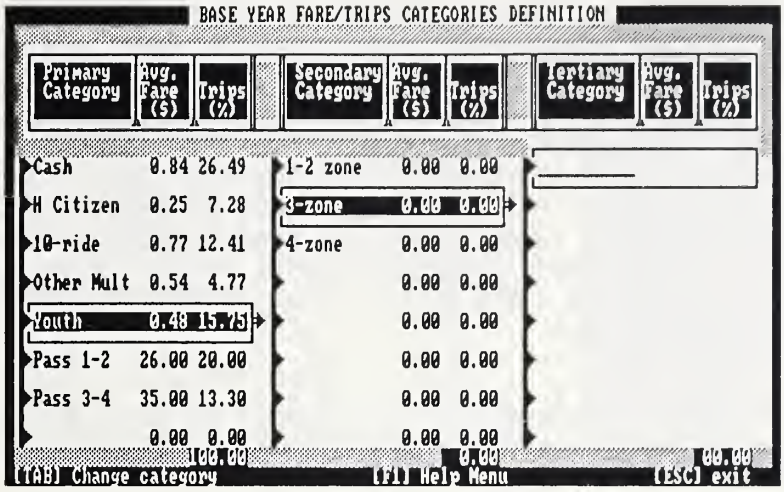
The ASSIGN. VARIABLE pertains to the current highlighted PROP. OF EXPENSES. As an example, let's say the PROP. OF EXPENSES entered were 60.00 and 40.00, and the ASSIGN. VARIABLES entered were revenue miles and payhours. Now, if you wanted 40% to be payhours, then you would move the cursor to the PROP. OF EXPENSES column and to the 40.00 entry. Now move the cursor right (to the ASSIGN VARIABLE column) and then UP or DOWN to payhours. That's it. When the cursor is in the ASSIGN VARIABLE column you can also now allocate it to any number of the service types by pressing the corresponding number(s). A SOLID block next to the service type indicates it as being allocated. To 'unallocated' it, press the number again and the block disappears.

COMMENTS:

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field or down the list. (The *ACTIVE* message

	indicates the current column where the cursor is.)
F1	Shows the HELP MENU.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.,-	Valid input data for the numeric fields.
anytext	Valid input data for the EXPENSE OBJECT CLASS.
1-8	Selects or de-selects the service type when the cursor is in the ASSIGN. VARIABLE column. One or more service types can be selected.
ESC	Exit the screen.

PREVIOUS SCREEN: COST MODEL INPUT MENU



BASE YEAR FARE/TRIPS CATEGORIES DEFINITION

SCREEN DESCRIPTION:

Base year FARE/TRIPS & category definition input for up to 3 levels of fare/trips disaggregation. Depending upon the level of detail specification chosen from the LEVEL OF DETAIL menu, the input screen will display 1-3 columns.

WHAT TO DO:

Enter each disaggregate category of fare/trips in terms of their title, average fare paid(in $), and market share (in %) of the base month trips for up to 3 levels of disaggregation.
The 3 fields to be input are:

1) PRIMARY/SECONDARY/TERTIARY CATEGORY

Various fare/trips categories are input here. A title can not exceed ten characters. Titles for the secondary and tertiary categories are specified in a similiar fashion.

2) AVG. FARE ($)

Mean fare paid by all riders in each fare/trips market subgroup is entered here. Format is nn.nn.

3) TRIPS (%)

Proportion of overall base month trips belonging to a particular fare/trips subgroup is input here in the format nn.nn. The sum total of this column is displayed at the bottom of the table for each level of data specification. Format is nn.nn. The primary trips column should total 100%.

HOW TO DO:

Use the arrow keys to move to the desired location, then type in the field value. The open box indicates which category you are entering data for. For each of the eight categories in the leftmost column(1st level), you can define up to 8 subcategories within those categories(2nd level). Then within those 8 subcategories, you can define 8 subcategories within those subcategories(3rd level). Supposing now that you wish to enter subcategories for the YOUTH category shown above. First, move the open box to

the category YOUTH using the UP or DOWN arrow. Next, press the TAB key. This fixes a dark band on the YOUTH category and place an open box with a cursor in the secondary category column. You now can enter subcategories for YOUTH. If you then wished to even define subcategories for 3-ZONE, place the open box on the 3-ZONE subcategory and press the TAB key.

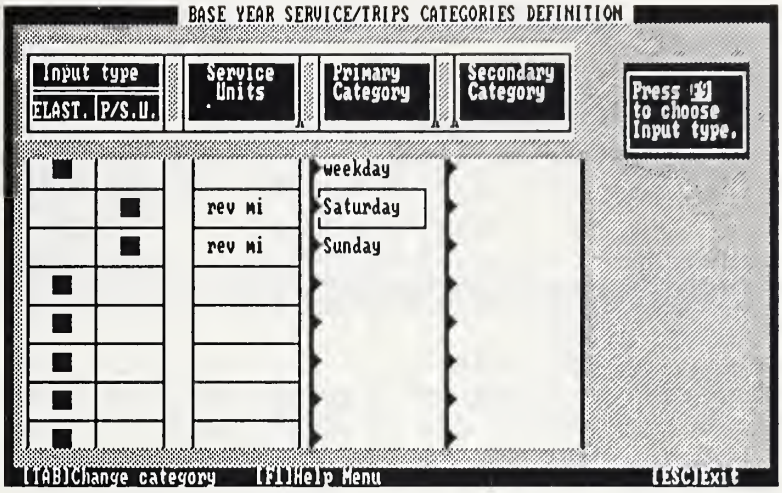
COMMENTS:

When adding or deleting categories, be sure to keep the categories at the top of the 8 rows. In other words, blank fields should be the bottommost of the 8 rows.

When the rightmost field has just been entered, the input box will automatically move down to the next category. If the input box was at the very bottom, it will then move to the top of the column, and the box covering the columns to the left will advance downward one category. This is to aid in entering data.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
TAB	Moves open input box to NEXT level. If the open box is at the highest level, then you are returned back to level 1.
SHFT-TAB	Moves open input box to PREVIOUS level.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data for avg. fare and trips fields.
anytext	Valid input data for category name field.
ESC	Exit the screen.

PREVIOUS SCREEN: LEVEL OF DETAIL SPECIFICATION FOR FARE/TRIPS



BASE YEAR SERVICE/TRIPS CATEGORIES DEFINITION

SCREEN DESCRIPTION:

Base year service/trips category definition input. Depending upon the level of detail specification chosen from the LEVEL OF DETAIL menu, the input screen will display 1-2 category columns.

WHAT TO DO:

Enter each disaggregate category of service in terms of their title and service units for up to 2 levels of disaggregation. Also, indicate which method (Elasticity or Passenger/service unit type) should be used for each level 1 category in estimating the impact of service changes. Here is the description of the 3 fields:

1) PRIMARY/SECONDARY CATEGORY

The title of the Service/Trips category is filled in here using no more than 10 characters.

2) INPUT TYPE

Specify the method to be used for the evaluation of service changes. ELAST. refers to the elasticity based method. P/S.U. represents passenger per service unit, in other words, service-productivity-based method.

3) SERVICE UNITS

Enter the units that the values you enter will be based on. This is for your own reference and is optional. The model permits the flexiblity of defining the measure of level and quality of service in any unit (e.g. revenue hours, platform hours, vehicle miles, etc.).

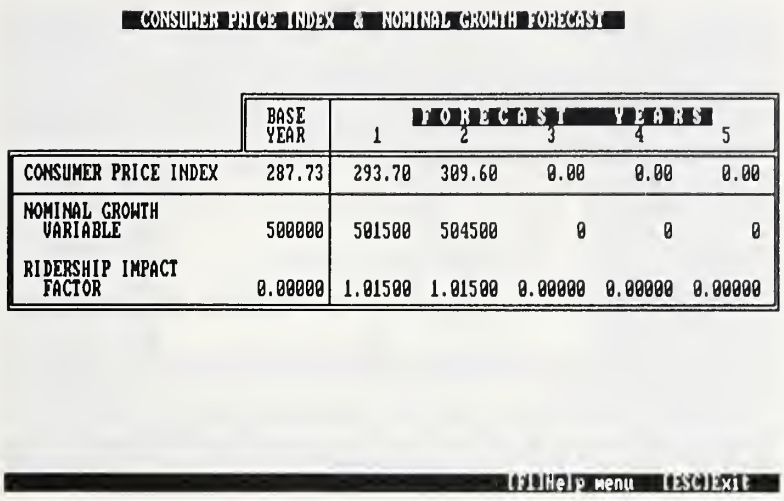
HOW TO DO:

Use the arrow keys to move to the desired field, then type in the service units and category name. To enter category names for the subcategories in level 2, use the TAB key as explained in the BASE/YEAR FARE/TRIPS CATEGORIES DEFINITION screen. When entering category names for level 1, you should also select the INPUT TYPE by pressing the F9 key. This moves the small black square under one of the two input types.

COMMENTS:
None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Toggles the black box between the two INPUT TYPEs.
TAB	Moves open input box to NEXT level. If the open box is at the highest level, then you are returned back to level 1.
SHFT-TAB	Moves open input box to PREVIOUS level.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
anytext	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: LEVEL OF DETAIL SPECIFICATION FOR SERVICE/TRIPS



CONSUMER PRICE INDEX & NOMINAL GROWTH FORECAST

SCREEN DESCRIPTION:

Yearly forecast of Consumer Price Index & Nominal Growth input for up to 5 years.

WHAT TO DO:

Type in the base year and forecast year values. Can forecast up to 5 years. The nominal growth variable can be any demographic variable (e.g., employment, population). See Methodology section, step 2 for more information.

HOW TO DO:

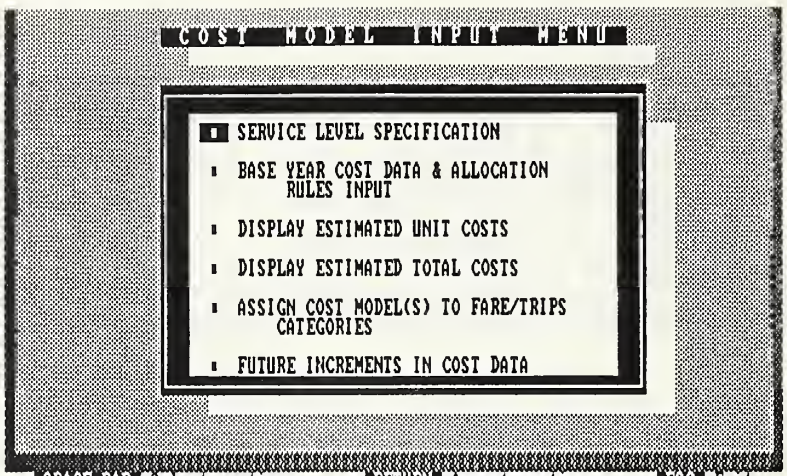
Use the arrow keys to move to the desired field, then type in the value.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: INPUT FARE/REV MENU



COST MODEL INPUT MENU

SCREEN DESCRIPTION:
Cost model input menu.

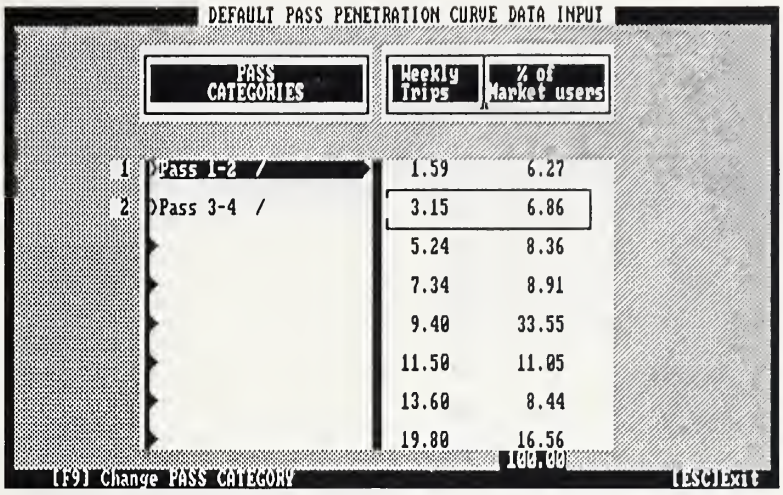
WHAT TO DO:
Select one of the options.

HOW TO DO:
Press the SPACE BAR to select the option, then press the RETURN key. If you don't wish to enter any data, then press the ESC key.

COMMENTS:
The only restriction in this menu is that you must choose the SERVICE LEVEL SPECIFICATION option before choosing any other option.

KEY	FUNCTION
UP,DOWN, SPACE	Moves the cursor the desired option.
RETURN	Accepts that option where the highlight is positioned.
ESC	Exit the screen and don't input any base year data.

PREVIOUS SCREEN: INTERACTIVE TRANSIT POLICY EVALUATION MODEL



DEFAULT PASS PENETRATION CURVE DATA INPUT (1)

SCREEN DESCRIPTION:

This screen accepts the basic input for generating up to 16 pass penetration curves.

WHAT TO DO:

For each pass category, fill the following 2 columns:

1) WEEKLY TRIPS

The average # of weekly trips taken by a group of system riders. The format is nn.nn.

2) % OF MARKET USERS

The proportion of a particular transit users pass market (market = pass users plus users in competing fare categories) belonging to a weekly trip frequency class. The format is nnn.nn. See Methodology, Step 5, A.1.2 for more information.

HOW TO DO:

Under the column "PASS CATEGORIES", the title of each pass fare category defined earlier appears in a sequential manner. For data entry, first move the dark band to a particular pass category using the F9 key. Then, on the right side of the table, enter the data within the box.

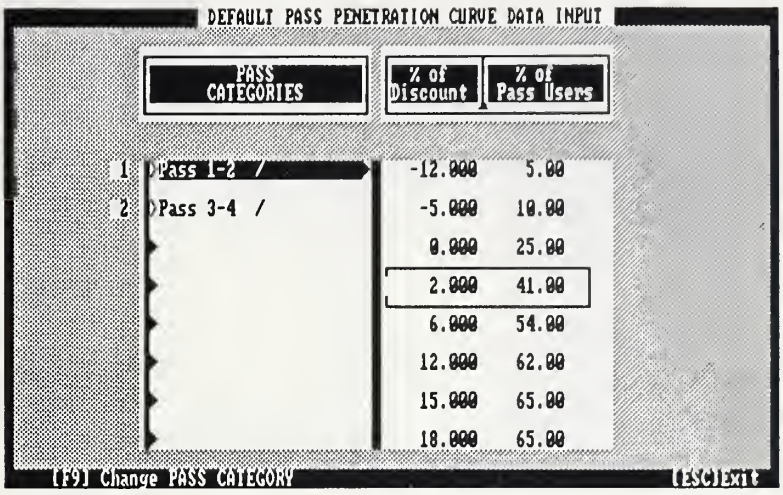
This box will automatically move down to the next line once data entry of the right most field is completed. On completion of this table, the data input box automatically loops back to the first line of the table.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Allows entering of data for next pass category.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: PASS COMPETING FARE CATEGORIES INPUT



DEFAULT PASS PENETRATION CURVE DATA INPUT (2)

SCREEN DESCRIPTION:

This screen accepts the basic input for generating up to 16 pass penetration curves.

WHAT TO DO:

For each pass category, fill the following 2 columns:

1) % OF DISCOUNT
   The average discount rate provided for prepaid pass buyers compared to the cash fare for the same number of trips expressed as a percentage.

2) % OF PASS USERS
   The proportion of transit pass users market using pass in a particular discount category. See equation 5.10 in methodology section for more detail.

HOW TO DO:

Under the column "PASS CATEGORIES", the title of each pass fare category defined earlier appears in a sequential manner. For data entry, first move the dark band to a particular pass category using the F9 key. Then, on the right side of the table, enter the data within the box.

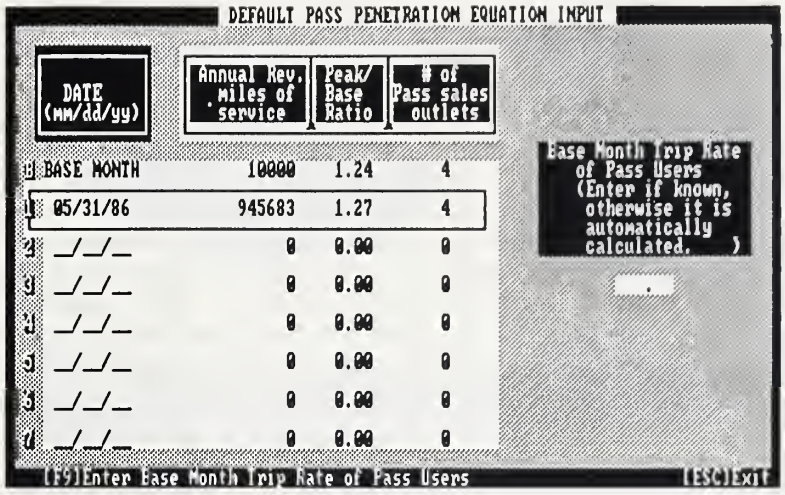
This box will automatically move down to the next line once data entry of the right most field is completed. On completion of this table, the data input box automatically loops back to the first line of the table.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Allows entering of data for next pass category.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: DEFAULT PASS PENETRATION CURVE DATA INPUT (1)



DEFAULT PASS PENETRATION EQUATION DATA INPUT

SCREEN DESCRIPTION:

Input data screen for the estimation of pass users trip making rate and their market penetration rate.

WHAT TO DO:

First, enter the date of policy change. Since the trip rate of pass users are influenced by the service level provided during off-peak periods, you should enter the future dates on which the service changes are envisaged. The format is mm/dd/yy.

For a particular date, fill the following 3 columns:

1) ANNUAL REV. MILES OF SERVICE
   The proposed total number of revenue miles of service for the year.

2) PEAK/BASE RATIO
   It is defined as follows:

$$\text{Peak/Base Ratio} = \frac{\text{No. of rev. vehicles during peak}}{\text{No. of rev. vehicles during base}}$$

3) # OF PASS SALES OUTLETS
   The number of pass sales outlets existing or proposed within the service area.

Also, if you know the base month trip rate of pass users (from survey data, for example) then fill in the value at the right. Otherwise, the program will automatically calculate it.

HOW TO DO:

Type in the date being sure to use leading 0's. If the date is invalid, then the date field is blanked out until a valid date is entered. Next, enter the remaining 3 fields for that date. To move to the next date, use the DOWN arrow key when the cursor is NOT in the date field.
To enter the BASE MONTH TRIP RATE OF PASS USERS, press the F9 key and the cursor will move to that field at the right.

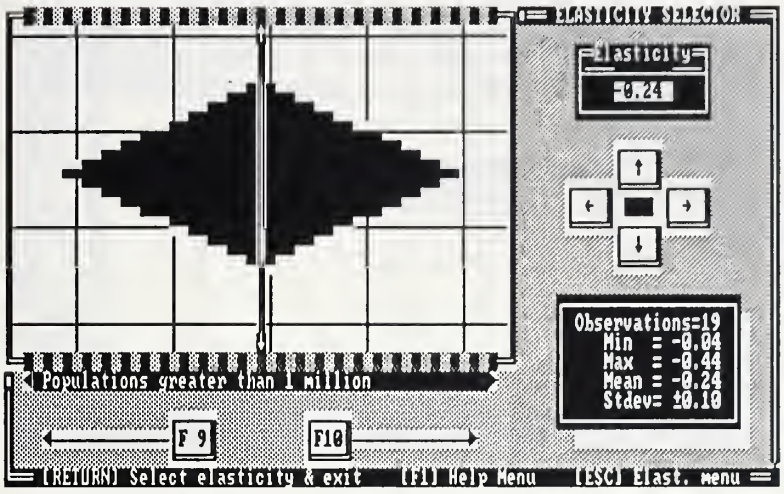
Entering a '0.0' in this field will clear it.

COMMENTS:

All dates entered must be from lowest to highest. For example, the date entered in position 4 should be a later date than the one entered in 2 and 3, and likewise earlier than 5,6,7, and 8. Also, there can not be any blank rows between dates. That is, do not enter a date in position 1,2, and 4 and leave position 3 blank. Fill positions 1,2, and 3.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Allows entering of BASE MONTH TRIP RATE OF PASS USERS.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: PASS FARE CATEGORY IDENTIFIER



ELASTICITY SELECTOR

SCREEN DESCRIPTION:

An enlarged graphical view of ONE subgroup data set that was selected. The statistics of that data set are shown at the bottom right. The object in the window is a graphical representation of the statistics.

WHAT TO DO:

Select an elasticity value by positioning the vertical bar.

HOW TO DO:

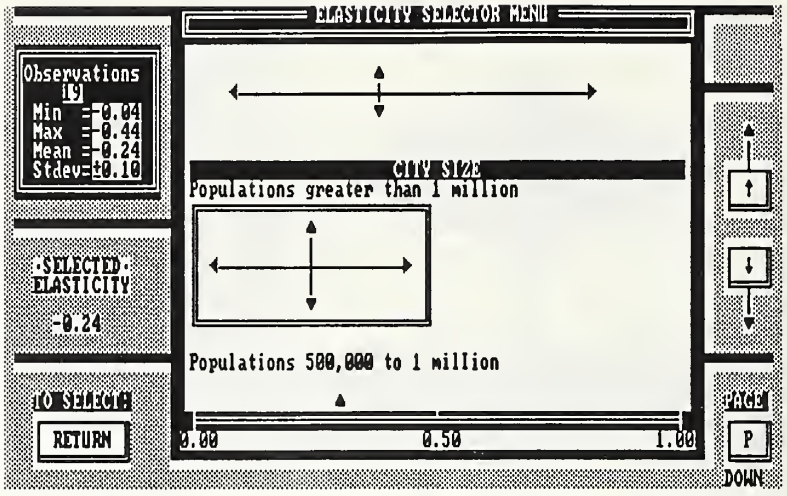
After having selected an elasticity model from the menu, move the vertical bar using the F9 and F10 keys to select the elasticity value. The current value is shown at the top right. Then press the RETURN key when done. Press the ESC key to return back to the ELASTICITY SELECTOR MENU.

COMMENTS:

The use of the arrow keys are only necessary if the object is larger than the window.

KEY	FUNCTION
F1	Displays HELP menu.
F9	Moves the vertical bar LEFT.
F10	Moves the vertical bar RIGHT.
RETURN	Returns to the ELASTICITY INPUT screen and automatically fills in the elasticity chosen.
ESC	Returns to the ELASTICITY MENU so you can choose a different data set.
ARROWS	Moves the window view.

PREVIOUS SCREEN: ELASTICITY SELECTOR MENU



ELASTICITY SELECTOR MENU

SCREEN DESCRIPTION:

A menu of various data sets shown graphically (in the window) and numerically (upper left) of all information pertaining to the observed distribution of elasticity values within each market subgroup. A window is provided so that you can scan through the many subgroups and choose one.

The statistical values shown at the upper left correspond to the graphical figure enclosed in the double-lined box. The left edge of the figure is the minimum data value, the right edge is the maximum value, the vertical line is the mean value, the height of the vertical bar is the # of values, and the high-intensity part of the figure shows the standard deviation.

WHAT TO DO:

Choose a particular data set from where you want to choose an elasticity value by positioning the double-lined box.

HOW TO DO:

Press the UP arrow key to move up to the next data set or the DOWN arrow key to move downward. To move faster through the data sets, press the 'P' key which will 'page' through in the direction of the last arrow key pressed. The last chosen elasticity of the boxed figure is displayed at the left.

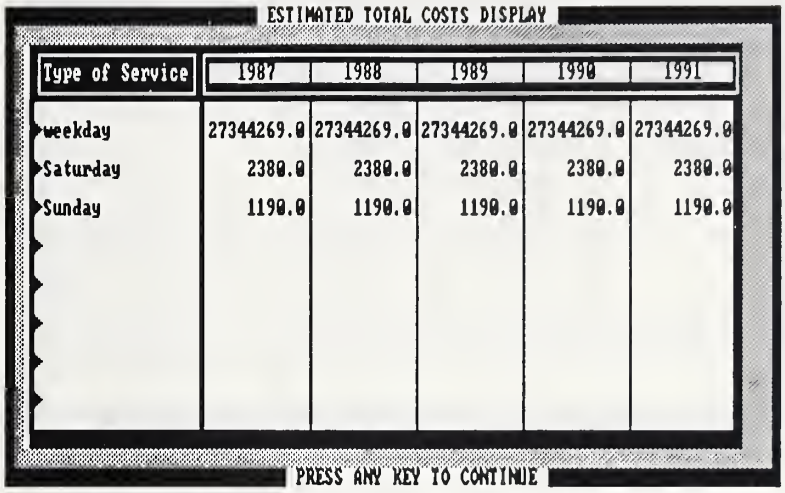
Then press the RETURN key when done.

COMMENTS:

None

KEY	FUNCTION
UP,DOWN	Move the double-lined box UP or DOWN to the next set.
P	Page UP or DOWN through the data sets.
PgUp	Page UP through the data sets.
PgDn	Page DOWN through the data sets.
RETURN	Selects the boxed data set.

PREVIOUS SCREEN: (FARE or SERVICE) ELASTICITIES INPUT



ESTIMATED TOTAL COSTS DISPLAY

SCREEN DESCRIPTION:

Display of estimated total costs.

WHAT TO DO:

View the results, then press any key to return to the cost menu.

HOW TO DO:

Values computed and filled in by model.

COMMENTS:

The Total costs were calculated by the following:

Cost allocation model for service type "r":

$$TC_r = \sum_j (UC_{jr} * S_{jr})$$

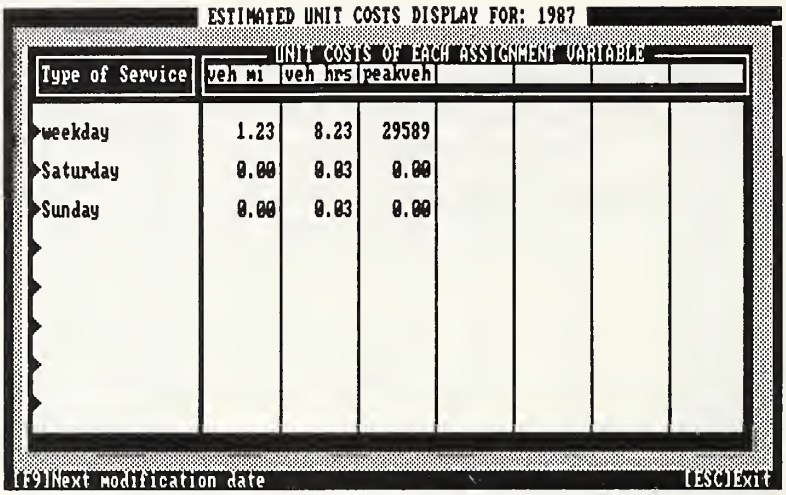
Where:

UC_{jr} = Unit cost of the assignment variable j for service service type r. (See the COMMENTS of ESTIMATED UNIT COST DISPLAY screen)

S_{jr} = Value of assignment variable j for the service type r.

KEY	FUNCTION
anykey	Exit the screen.

PREVIOUS SCREEN: COST MODEL INPUT MENU



ESTIMATED UNIT COSTS DISPLAY

SCREEN DESCRIPTION:

Display of estimated unit costs.

WHAT TO DO:

View the results then press the ESC key to return to the cost menu.

HOW TO DO:

Values computed and filled in by model. Use F9 to view estimates of following years.

COMMENTS:

The Unit costs were calculated using the following:

Expense under object class "i" allocated to the asignment variable "j" and service type "r":

$$E_{ijr} = E_i * PE_i * (S_{jr} / \sum_{\text{item}} S_{jr})$$

Total expense allocation to the variable "j" and service type "r":

$$E_{jr} = \sum_i E_{ijr}$$

Unit cost of the assignment variable for service type "r":

$$UC_{jr} = E_{jr} / S_{jr}$$

Where:

E_i = Total $ amount expense in the object class i. Increased by percentage that was input in the FUTURE INCREMENTS IN COST DATA screen.

PE_i = Proportion of base year cost under expense object class i considered for allocation.

S_{jr} = Value of assignment variable j for the service type r.

m = Subset of the service types ($m \in r$) considered under each expense class allocation.

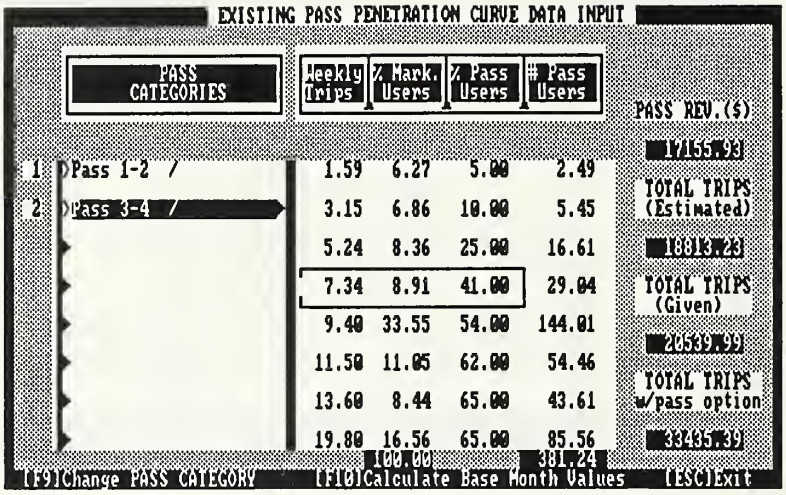
i = Subscript representing expense object class (e.g., operators salaries, fuel and lubricants, etc.).

j = Subscript representing assignment variable (e.g., revenue hours, revenue miles, peak buses, etc.).

r = Subscript representing types of serivce (e.g., commuter, local peak, etc.).

KEY	FUNCTION
ESC	Exit the screen.
F9	To view data for another year.

PREVIOUS SCREEN: COST MODEL INPUT MENU



EXISTING PASS PENETRATION CURVE DATA INPUT

SCREEN DESCRIPTION:

This screen accepts the basic input for generating up to 16 pass penetration curves.

WHAT TO DO:

For each pass category, fill the following 3 columns:

1) WEEKLY TRIPS

The average # of weekly trips taken by different groups of system riders. The format is nn.nn.

2) % OF MARKET TRIPS

The proportion of a particular pass market (pass trips plus trips taken by other competing fare categories) belonging to a weekly trip frequency class. The format is nnn.nn.

3) % OF PASS TRIPS

The proportion of overall trips within each weekly trips class. The format is nn.nn.

HOW TO DO:

Under the column "PASS CATEGORIES", the title of each pass fare category defined earlier appears in a sequential manner. For data entry, first move the dark band to a particular pass category using the F9 key. Then, on the right side of the table, enter the data within the box. This box will automatically move down to the next line once data entry of the right most field is completed. On completion of this table, the data input box automatically loops back to the first line of the table.

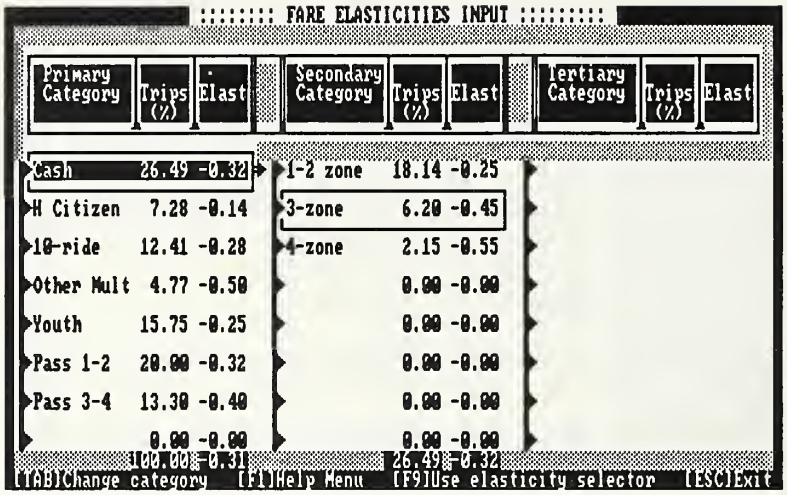
COMMENTS:

The '% Mark. Users' and '# Pass Users' column are both totalled at the bottom. The '# Pass Users' category is computed within the model.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.

F9	Allows entering of data for next pass category.
F10	Calculates the # pass users and the base month values.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: PASS COMPETING FARE CATEGORIES INPUT



FARE ELASTICITIES INPUT

SCREEN DESCRIPTION:

Fare elasticities input. Depending upon the level of detail specification chosen from the LEVEL OF DETAIL menu, the input screen will display 1-3 columns.

WHAT TO DO:

Enter the fare elasticity values for each category. The category names and base trips re-appear here from the category definition screen to aid in filling out the elasticity values. The format of the field is + or - n.nn.

HOW TO DO:

Use the arrow keys to move to the desired field, then type in the elasticity value. To enter elasticity values for the subcategories in level 2 or 3, use the TAB key as explained in the BASE/YEAR FARE/TRIPS CATEGORIES DEFINITION screen.

COMMENTS:

When adding or deleting categories, be sure to keep the categories at the top of the 8 rows. In other words, all category fields that are blank should be at the bottom of the 8 rows.

There are also TWO other interesting features available on this screen:

ELASTICITY SELECTOR : This is to aid in selecting an elasticity value. By pressing the F9 key, a menu will appear where you can either choose factor(s) from an adjustment factors table for the estimation of disaggregate elasticities, or consult the graphical display of disaggregate elasticites among various transit properties. These two features are described at the ADJUSTMENT FACTORS TABLE screen and ELASTICITY SELECTOR screen.

CONSISTENCY CHECK : While using the disaggregate elasticity value for each market subgroup, one would expect the aggregate elasticity value to be reasonably close to the weighted average of the disaggregate values, as expressed below:

$$e = \sum_{i=1}^{n} e_i s_i$$

where: e = the aggregate elasticity
e_i = the elasticity for market group i
s_i = share in market group i, such that $\sum_i s_i = 1$

For accurate results, the aforementioned elasticity consistency rule should be checked at each level of disaggregation.
For each category of the fare/trips classification, the model estimates the aggregate elasticity value and displays it at the bottom of the elasticity input column. If the system-wide aggregate fare elasticity value is known, then the system-wide value should be close to the displayed value of the first level. Similarly, the elasticity for each fare/trips subgroup of the primary category should be reasonably close to the estimated and displayed aggregate elasticity at the secondary level. The same should hold true between the subgroups of the secondary level and their third level disaggregation. A user could overlook this consistency feature if he or she wished. However, the degree of error in the output results will depend upon the level of inconsistency accepted. The above explanation can also be expressed in the following manner:

$$e = \sum_{i=1}^{n} e_i s_i$$

$$e_i = \sum_{j=1}^{n} e_{ij} s_{ij}$$

$$e_{ij} = \sum_{r=1}^{n} e_{ijr} s_{ijr}$$

where:
$e_{i,j,r}$ = the elasticity
i,j,r = subscripts representing 1st,2nd, & 3rd level disaggregation, respectively.
s = share in market group such that

$$\sum_i si=1, \quad \sum_j sij=1, \text{ and } \sum_r sijr=1$$

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Display elasticty selector menu.

TAB	Moves open input box to NEXT level. If the open box is at the highest level, then you are returned back to level 1.
SHFT-TAB	Moves open input box to PREVIOUS level.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
-,+	Change elasticity to negative or positive.
ESC	Exit the screen.

PREVIOUS SCREEN: FARE INPUT MENU

FARE INPUT MENU

SCREEN DESCRIPTION:

Fare input data menu.

WHAT TO DO:

Select one of the options depending on where you wish to enter data.

HOW TO DO:

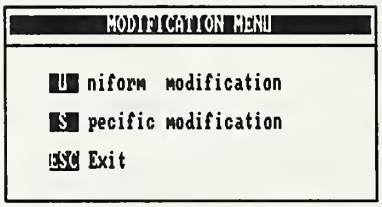
Press the SPACE BAR to select the option, then press the RETURN key. If you don't wish to enter any data, then press the ESC key.

COMMENTS:

The FILE COMMENTS option allows you to enter up to 3 lines of text about the file for your own reference.
The only restriction in this menu is that you must choose the LEVEL OF DETAIL & BASE DATA option before choosing any other option other than FILE COMMENTS.

KEY	FUNCTION
UP,DOWN, SPACE	Moves the cursor the desired option.
RETURN	Accepts that option where the highlight is positioned.
ESC	Exit the screen and don't input any base year data.

PREVIOUS SCREEN: INPUT FARE/REV MENU



FARE MODIFICATION INPUT MENU

SCREEN DESCRIPTION:

Modification menu.

WHAT TO DO:

Select the type of fare change to occur at a future date. A UNIFORM fare change will change ALL category fares by the same percentage at a particular date. A SPECIFIC fare change allows you to change each individual category by a different percentage at a particular date.

HOW TO DO:

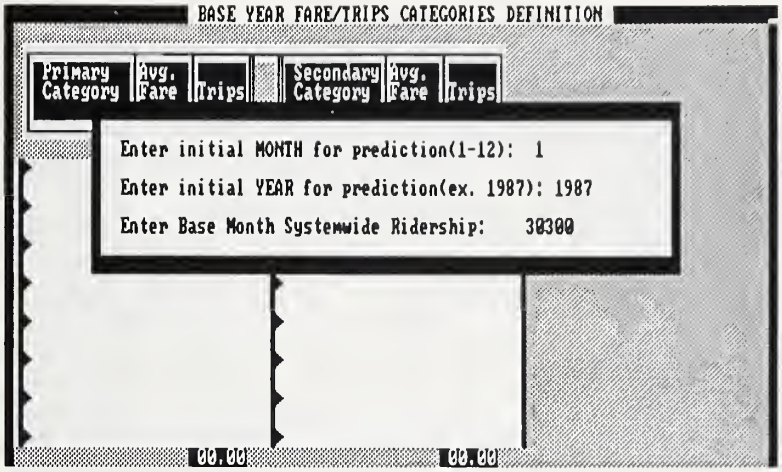
Press the 'U' or 'S' key to select the option. If you do not wish to make any modifications, then press the ESC key.

COMMENTS:

None.

KEY	FUNCTION
U,S	Selects an option.
ESC	Exit the screen.

PREVIOUS SCREEN: FARE INPUT MENU



FARE/REVENUE BASE DATA INPUT

SCREEN DESCRIPTION:

Base month data.

WHAT TO DO:

Enter the Initial MONTH and YEAR of the prediction. Also, enter the BASE MONTH RIDERSHIP.

HOW TO DO:

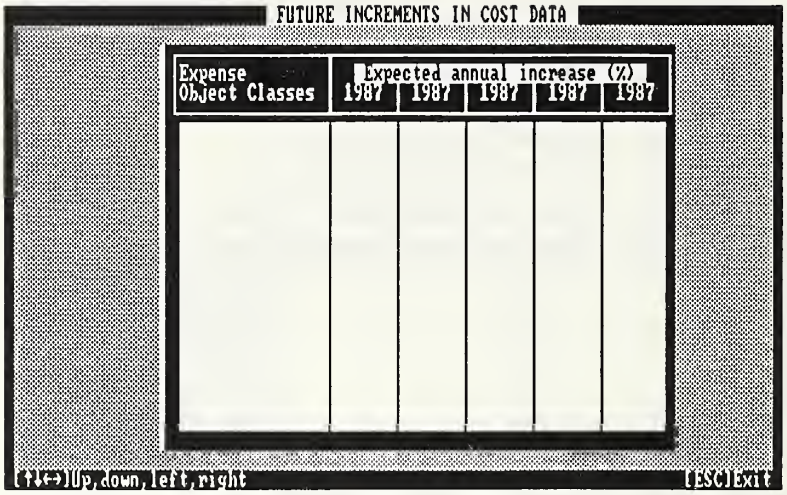
Type in the initial MONTH value by entering a 1-12, then press RETURN. Type in the initial YEAR by entering a 4 digit date such as '1987'. Type in the BASE MONTH RIDERSHIP. Then when you press RETURN, then screen will pause for about 3 seconds. If you wish to change any of these 3 data values, you must re-enter the LEVEL OF DETAIL option.

COMMENTS:

None.

KEY	FUNCTION
RETURN	Format the field, then advance to the next field.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.

PREVIOUS SCREEN: LEVEL OF DETAIL SPECIFICATION FOR FARE/TRIPS



FUTURE INCREMENTS IN COST DATA

SCREEN DESCRIPTION:

Percentage increase for an expense object class defined in the BASE YEAR COST DATA & ALLOCATION RULES INPUT screen.

WHAT TO DO:

Enter the yearly percentage increase for a particular expense object class. If, for example, you enter a 10 for the % increase for the 1st two years, then the object class amount will increase 10% the first year and 10% more the next year.

HOW TO DO:

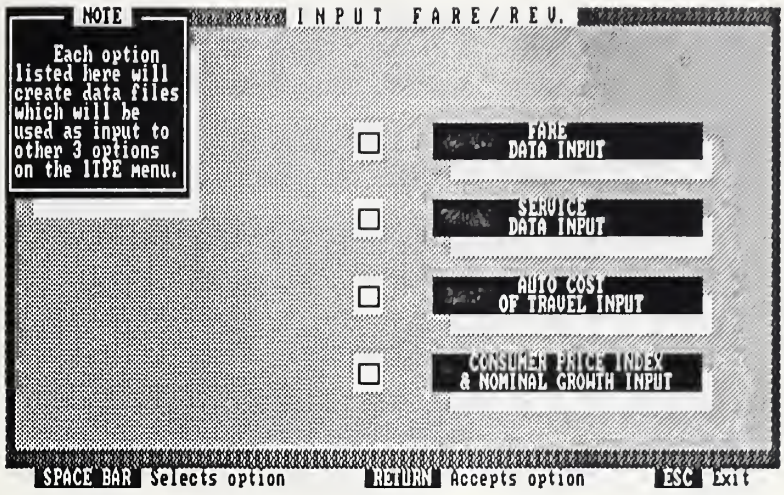
Use the arrow keys to move to the desired year, then type in the percentage value.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: COST MODEL INPUT MENU



INPUT FARE/REV INPUT MENU

SCREEN DESCRIPTION:

Fare/Revenue input menu.

WHAT TO DO:

Select one of the 4 options.

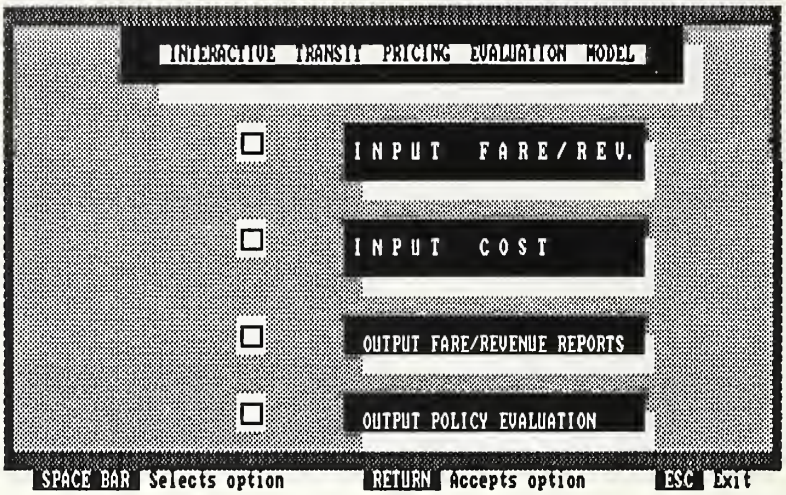
HOW TO DO:

Press the SPACE BAR to select the option, then press the RETURN key. If you wish not to enter fare/revenue input, then press the ESC key. If you choose any of the 4 options, you will be prompted for the filename of a data file. Each option has an input data file associated with it which is further explained in Appendix C.

COMMENTS:

KEY	FUNCTION
UP,DOWN, SPACE	Moves the cursor the desired option.
RETURN	Accepts that option where the highlight is positioned.
ESC	Exit the screen and return to DOS prompt.

PREVIOUS SCREEN: INTERACTIVE TRANSIT POLICY EVALUATION MODEL



INTERACTIVE TRANSIT POLICY EVALUATION MODEL

SCREEN DESCRIPTION:

ITPE MAIN MENU.

WHAT TO DO:

Select one of the 4 options.

HOW TO DO:

Press the SPACE BAR to select the option, then press the RETURN key. If you wish to exit the ITPE program, then press the ESC key. If you choose:

INPUT FARE/REV: You will see an INPUT FARE/REV. MENU where you can create 4 input data files.

INPUT COST: You will be prompted for two input data files. The FARE input file that the program asks for is the input data file created from the INPUT FARE/REV option. The COST input data file that the program asks for is explained in Appendix C.

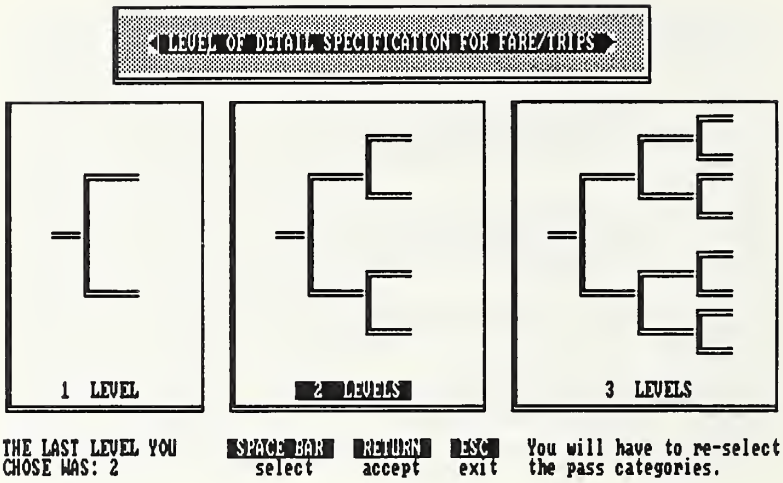
The output options: You will see the OUTPUT FARE/REVENUE REPORTS screen.

COMMENTS:

The first option you should choose is the INPUT FARE/REV because the other options rely on that input data. Namely, the INPUT COST option uses the 4 fare data input files created from the INPUT FARE/REV. screen, the OUTPUT FARE/REVENUE REPORTS option also uses all 4 FARE/REV input data files, and OUTPUT POLICY EVALUATION uses both the 4 FARE/REV input data files and the COST input data file. There is no harm in choosing the other options first, as you will see that these options can not be carried out until you have created the necessary input data files required for that option.

KEY	FUNCTION
UP,DOWN, SPACE	Moves the cursor the desired option.
RETURN	Accepts that option where the highlight is positioned.
ESC	Exit the screen and return to DOS prompt.

PREVIOUS SCREEN: (This is the main menu.)



LEVEL OF DETAIL SPECIFICATION FOR FARE/TRIPS

SCREEN DESCRIPTION:

Level of detail specification menu. A user can set the model for up to 3 levels of fare/trips disaggregation. At each level, eight different subgroups can be defined under a single category.

WHAT TO DO:

Choose the level of detail.

HOW TO DO:

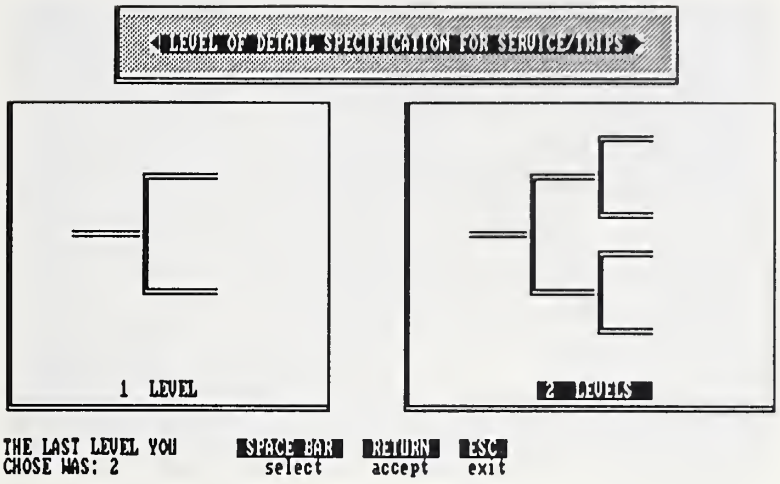
Press the SPACE BAR to move the highlight bar. Then press the RETURN key to accept it. Press the ESC key if you don't wish to enter any data.

COMMENTS:

A message at the bottom right will appear if you have already entered PASS penetration data. The reason for this is that re-entering this base data definition screen, moving some categories around or changing some names will cause the categories indicated as PASS categories in the PASS FARE CATEGORY IDENTIFIER screen to become incorrect. If you press the ESC key now, then you won't have to re-select the pass categories; however, if you press RETURN to enter the base data definition screen, then you will have to choose the PASS PENETRATION option from the INPUT FARE/REV menu screen and re-indicate which categories are pass categories.

KEY	FUNCTION
LEFT, RIGHT, SPACE	Moves the cursor the desired option.
RETURN	Accepts that option where the highlight is positioned.
ESC	Exit the screen and don't input any base year data.

PREVIOUS SCREEN: FARE INPUT MENU



LEVEL OF DETAIL SPECIFICATION FOR SERVICE/TRIPS

SCREEN DESCRIPTION:

See the FARE level of detail specification screen. The same rules apply except that there are only up to 2 levels of detail.

WHAT TO DO:

Choose the level of detail.

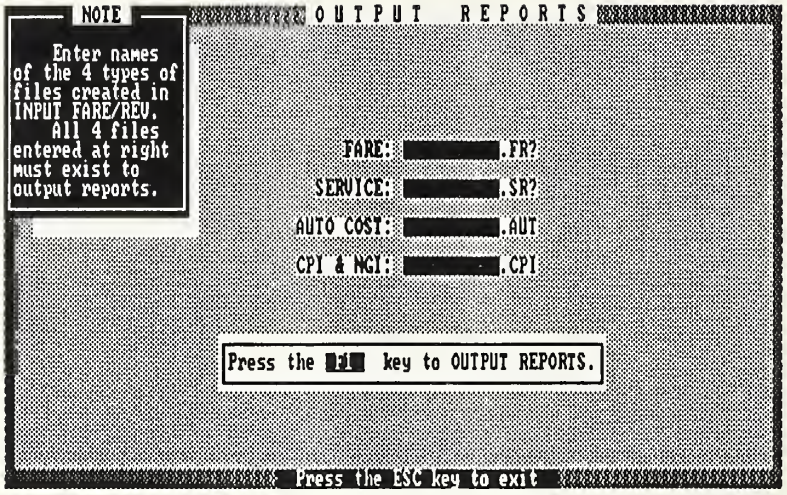
HOW TO DO:

Press the SPACE BAR to move the highlight bar. Then press the RETURN key to accept it. Press the ESC key if you don't wish to enter any base data.

COMMENTS:

KEY	FUNCTION
LEFT, RIGHT, SPACE	Moves the cursor the desired option.
RETURN	Accepts that option where the highlight is positioned.
ESC	Exit the screen and don't input any base year data.

PREVIOUS SCREEN: SERVICE INPUT MENU



OUTPUT REPORTS

SCREEN DESCRIPTION:

File input screen for outputing results.

WHAT TO DO:

Enter the filenames of the 4 types of files created from the INPUT FARE/REV menu option. If a particular file entered does not exist, a message on the screen will indicate that. After all 4 file names have been entered and found to exist, press the F1 key and the program will run the data through the ITPE model and allow you to view the results. If you do not wish to run the model, then press the ESC key to exit.

HOW TO DO:

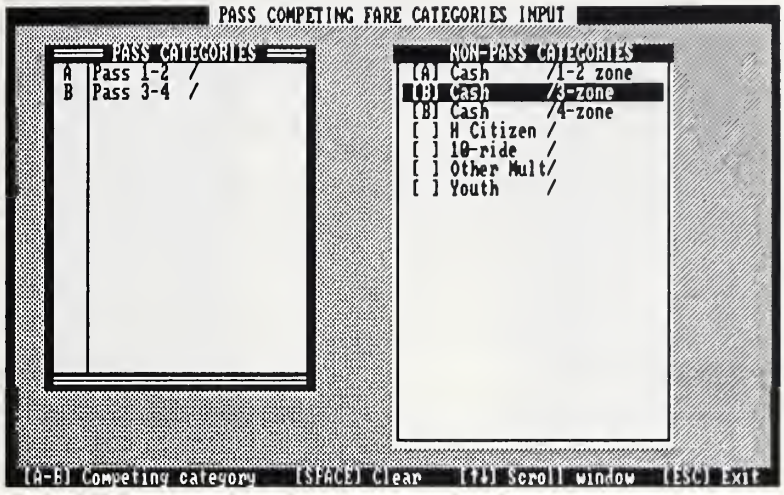
Type in the filenames. Use the arrow keys to move the cursor to another field.

COMMENTS:

After the F1 key is pressed (and the data files exist), you will be prompted for the # of years to run the model. At this time, press the 1,2,3,4, or 5 key. The number you should enter should be the same # of years forecasted when entering the AUTO COST data and CPI data, although it is not necessary. The smaller the #, the faster the model will run.

KEY	FUNCTION
UP,DOWN	Moves the cursor to another field.
RETURN	Formats the field & moves the cursor to the next field.
ESC	Exit the screen.
F1	If all files entered exist, then the input data will be run through the model.
anytext	Valid filename input data.

PREVIOUS SCREEN: INTERACTIVE TRANSIT POLICY EVALUATION MODEL



PASS COMPETING FARE CATEGORIES INPUT

SCREEN DESCRIPTION:

Categories in the left window are the ones previously indicated as PASS categories. Categories in the right window are the ones NOT indicated as PASS.

WHAT TO DO:

Indicate which NON-PASS categories compete with which PASS categories.

HOW TO DO:

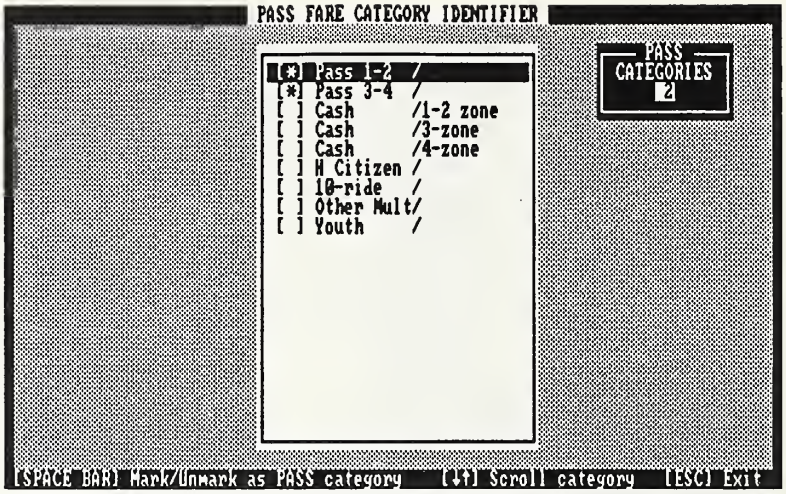
Use the arrow keys to move the highlighted bar UP or DOWN to a particular category, then press a letter corresponding to a PASS category shown in the left window. Pressing the SPACE BAR will unmark a category. Then press the ESC key when done.

COMMENTS:

None.

KEY	FUNCTION
UP,DOWN	Move the highlighted bar UP or DOWN.
LETTER	Indicates the pass category that competes with the highlighted category.
SPACE	Unmarks a category.
ESC	Exit the screen.

PREVIOUS SCREEN: PASS FARE CATEGORY IDENTIFIER



PASS FARE CATEGORY IDENTIFIER

SCREEN DESCRIPTION:

Display of all categories up to 2 levels in a scrollable window.

WHAT TO DO:

Indicate which categories are of unlimited use pass type.

HOW TO DO:

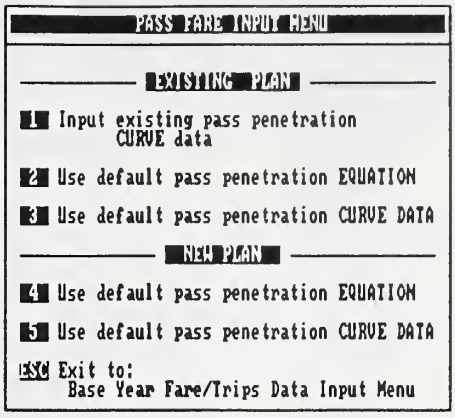
Use the arrow keys to move the highlighted bar UP or DOWN to a particular PASS category, then press the SPACE BAR to mark it as such. Pressing the SPACE BAR either marks or unmarks a category. An asterisk in front of the category indicates it as a pass type. The # of pass categories selected is shown at the top right. Press the ESC key when done.

COMMENTS:

This model permits fare/trip categories only up to two levels of specification in pass input, thus displaying up to a maximum of 64 fare/trip categories in the scrollable window. The maximum # of categories that can be identified as type pass cannot exceed 16.

KEY	FUNCTION
UP,DOWN	Move the highlighted bar UP or DOWN.
SPACE	Mark or Unmark a category as PASS.
ESC	Exit the screen.

PREVIOUS SCREEN: PASS FARE INPUT MENU



PASS FARE INPUT MENU

SCREEN DESCRIPTION:

Pass fare plan input menu.

WHAT TO DO:

Select one of the 5 different methodologies available for the evaluation of pass fare plan(s).

HOW TO DO:

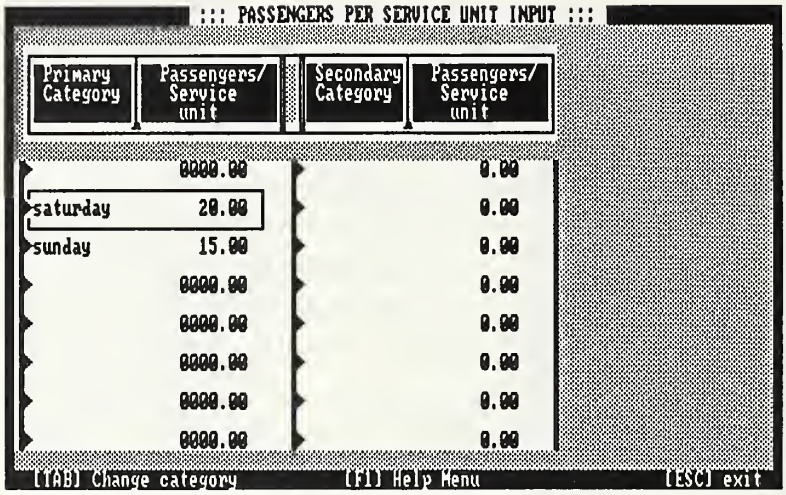
To select an option, press the 1,2,3,4, or 5 key. If you do not wish to input pass information, then press the ESC key.

COMMENTS:

The choice of an option will greatly depend upon the avaibility of the necessary data to generate pass penetration curve(s). The 1st option will be mostly used by those who can provide essential input pertaining to the use of the existing pass plan(s) at his/her agency. However, in cases where the required data for generating pass penetration curve(s) are not available, it will be necessary to select one of the remaining 4 options. Options 2 & 4 allow you to input pass penetration curve(s) data taken from another agency. Options 3 & 5 demand minimum data because an equation depicting the market penetration curve is internally made available for the analysis.

KEY	FUNCTION
1,2,3,4,5	To select an option.
ESC	Exit the menu.

PREVIOUS SCREEN: FARE INPUT MENU



PASSENGERS PER SERVICE UNIT INPUT

SCREEN DESCRIPTION:

Passengers/service unit input. Depending upon the level of detail specification chosen from the menu, the input screen will display 1-2 columns.

WHAT TO DO:

Enter the passengers/service unit for each category. The category names that re-appear here are from the BASE/YEAR SERVICE/TRIPS CATEGORIES DEFINITION screen. All values entered should, of course, use only one particular unit of measurement which was defined in the definition screen. The format for this field is nnnn.nn.

HOW TO DO:

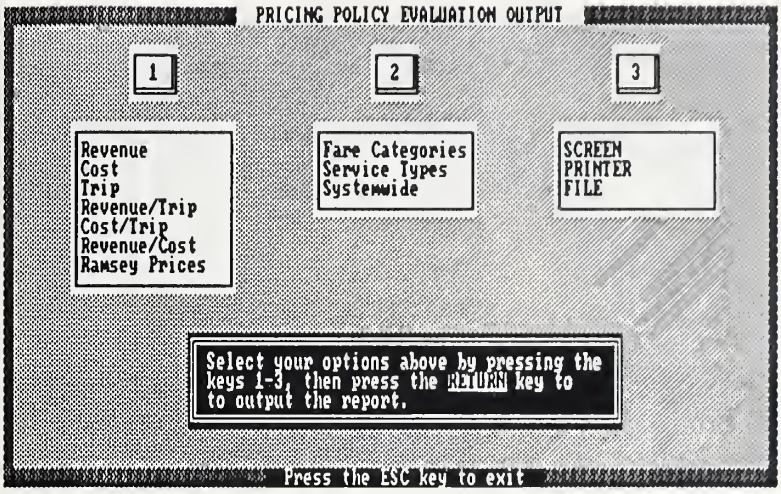
Use the arrow keys to move to the desired field, then type in the value. To enter elasticity values for the subcategories in level 2, use the TAB key as explained in the BASE/YEAR FARE/TRIPS CATEGORIES DEFINITION screen.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
TAB	Moves open input box to NEXT level. If the open box is at the highest level, then you are returned back to level 1.
SHFT-TAB	Moves open input box to PREVIOUS level.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
-,+	Change elasticity to negative or positive.
ESC	Exit the screen.

PREVIOUS SCREEN: SERVICE INPUT MENU



PRICING POLICY EVALUATION OUTPUT

SCREEN DESCRIPTION:

Policy evaluation report output selection screen.

WHAT TO DO:

Select the type of output you wish from the many combinations possible, then press RETURN to output the results.

HOW TO DO:

The type of output can be selected by positioning the highlight bar over the options you wish. The highlight bar is moved by pressing the 1,2, or 3 keys. After the bars are placed over the desired options, press the RETURN key to output the results.

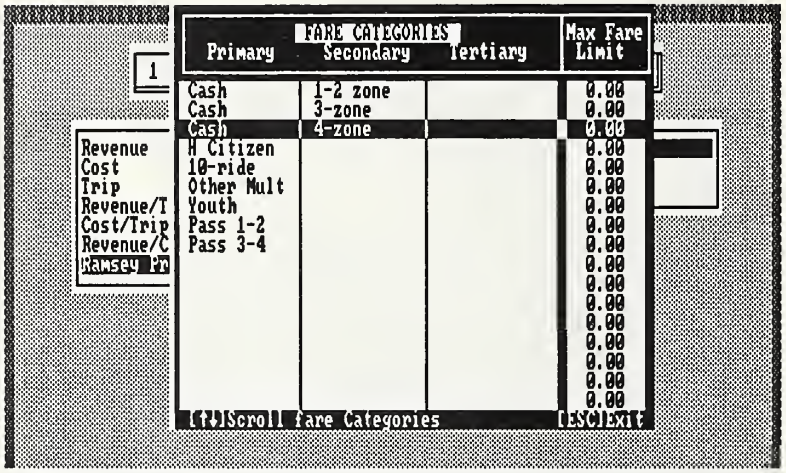
The RAMSEY PRICES option is the one option that will pop up another small menu. If you just wish to output the RAMSEY PRICES, then pick the 3rd option as indicated. The two other options allow you to enter any fare constraints, or input subsidy levels. These two options are explained in the RAMSEY FARE CONSTRAINTS and RAMSEY SUBSIDY LEVELS input screens. When the bar is resting on the RAMSEY PRICING option, option 2 will be locked on FARE CATEGORIES.

COMMENTS:

None.

KEY	FUNCTION
1,2,3	Moves the bar to select an option.
RETURN	Outputs the report using the highlighted options.
ESC	Exit the screen.

PREVIOUS SCREEN: OUTPUT REPORTS



RAMSEY FARE CONSTRAINTS

SCREEN DESCRIPTION:

Fare limits to be placed on fare categories.

WHAT TO DO:

Set a limit for any fare category. Then when Ramsey prices are calculated, that categories fare will not go higher than that limit. If you do not wish to set a limit, leave the limit set to zero. This field is optional.

HOW TO DO:

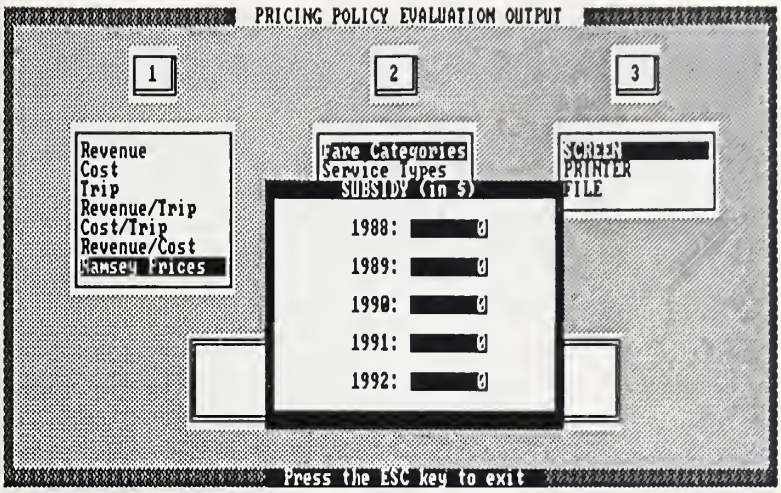
Use the arrow keys to move the cursor the desired field, then enter a fare limit.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: POLICY PRICING EVALUATION OUTPUT



RAMSEY SUBSIDY LEVELS

SCREEN DESCRIPTION:

Subsidy levels to be set for each year when calculating Ramsey pricing.

WHAT TO DO:

Enter a subsidy level in a $ amount. Entering a value is optional.

HOW TO DO:

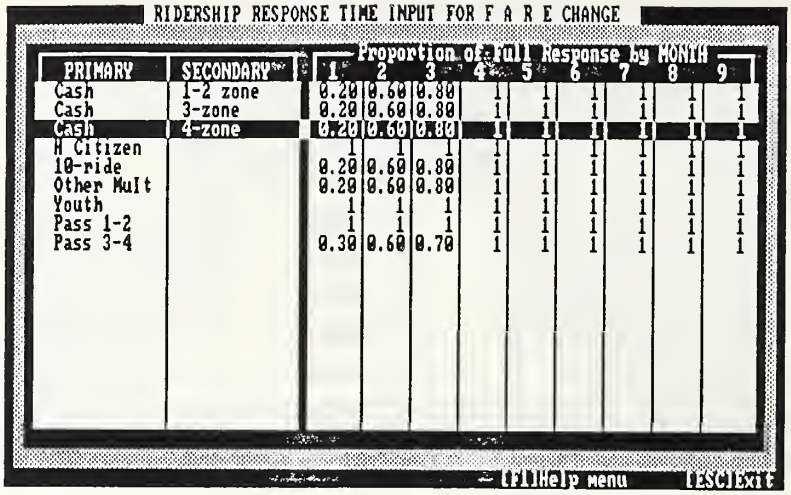
Use the arrow keys to move to the desired field, then enter a value.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: POLICY PRICING EVALUATION OUTPUT



RIDERSHIP RESPONSE TIME INPUT

SCREEN DESCRIPTION:

Ridership Response time input screen. On the left of the scrollable window are all of the level 1 & 2 categories.

WHAT TO DO:

For each category enter the proportion of full response of ridership to the effects of a FARE or SERVICE change. The proportions should increase monthly until reaching a value of 1, which signifies 100% adjustment to the change.

HOW TO DO:

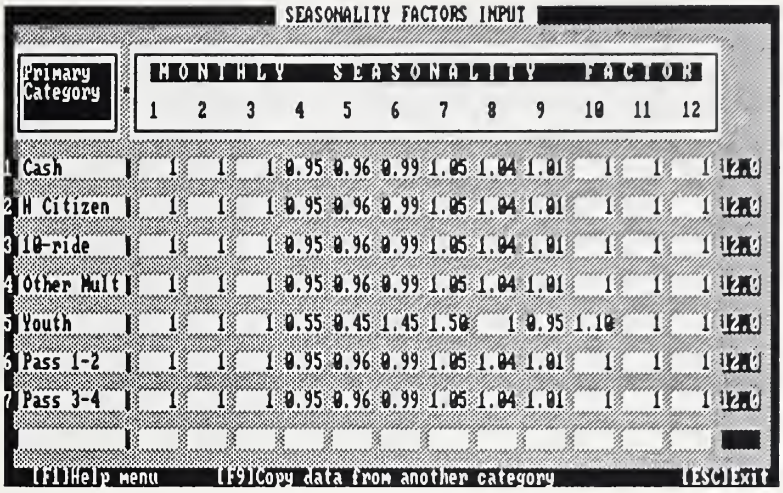
Use the arrow keys to move to the desired field, then type in the percentage value.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: FARE INPUT MENU



SEASONALITY FACTORS INPUT

SCREEN DESCRIPTION:

Seasonality factors input screen. On the left are the level 1 categories.

WHAT TO DO:

Fill in the seasonality factors for each category shown on the left. Numbers must be greater than zero. Factor scores reflect adjustments to observed ridership due to the time of year.

HOW TO DO:

Use the arrow keys to move to the desired field, then type in the seasonality factors value.

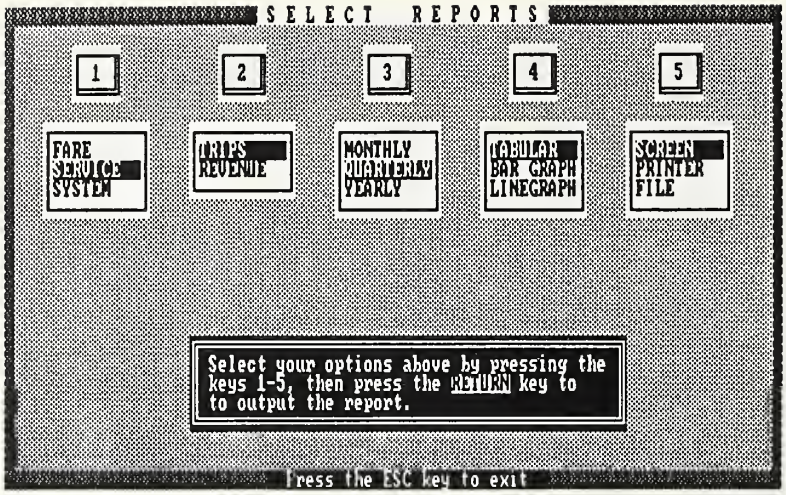
There is also the feature to copy all twelve monthly values to another category. Just move the cursor to the category that you want to fill in, then press the F9 key. You will be asked which category that you wish to copy data from. Then typing the 1-8 key will fill in the values for you.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Copies data from another category to the category the cursor is at.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
ESC	Exit the screen.

PREVIOUS SCREEN: FARE INPUT MENU



SELECT REPORTS

SCREEN DESCRIPTION:

Report output selection screen.

WHAT TO DO:

Select the type of output you wish from the many combinations possible, then press RETURN to output the results.

HOW TO DO:

The type of output can be selected by positioning the highlightbar over the options you wish. The highlight bar is moved by pressing the 1,2,3,4, or 5 keys. After the bars are placed over the desired options, press the RETURN key to output the results.

COMMENTS:

None.

KEY	FUNCTION
1	Moves the bar to select FARE,SERVICE, or SYSTEM.
2	Moves the bar to select TRIPS or REVENUE.
3	Moves the bar to select how to group data.
4	Moves the bar to select how to display data. The graph options can only output SYSTEM data, so key 1 will be locked on SYSTEM when you choose a graph. The LINE graph shows 6 individual changes: GROWTH, SEASONALITY, FARE, SERVICE, AUTO COST & TOTAL CHANGE The BAR graph shows the sum of the 6 individual changes plus the BASE RIDERSHIP or REVENUE, (NEW RIDERSHIP or REVENUE).
5	Moves the bar to select where to output the results.
RETURN	Outputs the report using the highlighted options.
ESC	Exit the screen.

PREVIOUS SCREEN: OUTPUT REPORTS

SERVICE ELASTICITIES INPUT

SCREEN DESCRIPTION:

Service elasticities input. Depending upon the level of detail specification chosen from the menu, the input screen will display 1-2 columns.

WHAT TO DO:

Enter service elasticity values, primary category trips as a percentage of base total trips, and the base month (initial) service level for each category that appears. Only categories from the BASE/YEAR SERVICE/TRIPS CATEGORIES screen which specified elasticity as the input type will be listed here.

HOW TO DO:

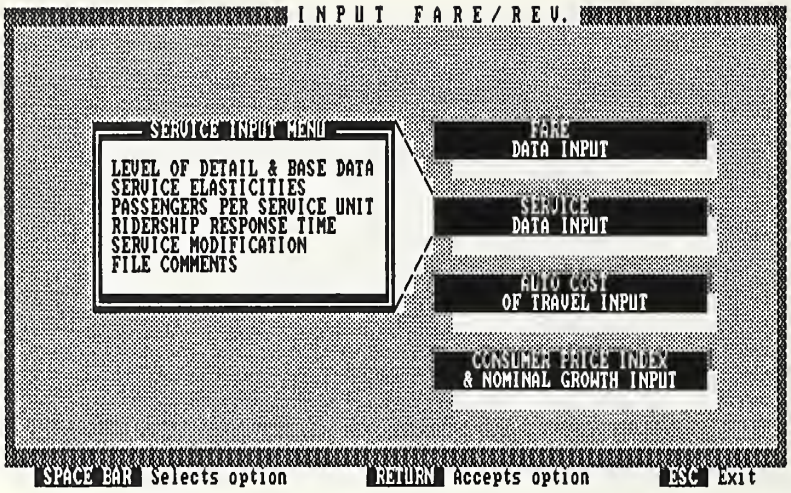
Use the arrow keys to move to the desired field, then type in thefield value. To enter field values for the subcategories in level 2, use the TAB key as explained in the FARE/TRIPS CATEGORY DEFINITION screen.

COMMENTS:

See the COMMENTS section from the FARE ELASTICITIES INPUT screen.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	Display elasticty selector menu.
TAB	Moves open input box to NEXT level. If the open box is at the highest level, then you are returned back to level 1.
SHFT-TAB	Moves open input box to PREVIOUS level.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
-,+	Change elasticity to negative or positive.
ESC	Exit the screen.

PREVIOUS SCREEN: SERVICE INPUT MENU



SERVICE INPUT MENU

SCREEN DESCRIPTION:

Service data menu.

WHAT TO DO:

Select one of the options depending on where you wish to enter data.

HOW TO DO:

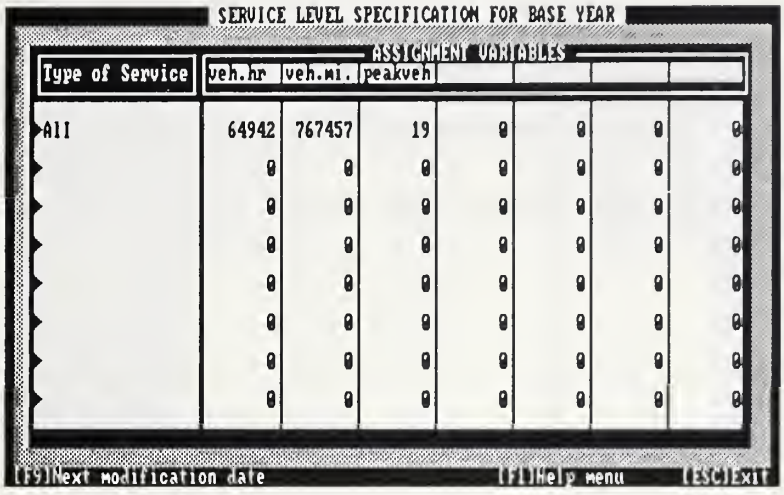
Press the SPACE BAR to select the option, then press the RETURN key. If you don't wish to enter any data, then press the ESC key.

COMMENTS:

The FILE COMMENTS option allows you to enter up to 3 lines of text about the file for your own reference.
The only restriction in this menu is that you must choose the LEVEL OF DETAIL & BASE DATA option before choosing any other option other than FILE COMMENTS.

KEY	FUNCTION
UP,DOWN, SPACE	Moves the cursor the desired option.
RETURN	Accepts that option where the highlight is positioned.
ESC	Exit the screen and don't input any base year data.

PREVIOUS SCREEN: INPUT FARE/REV MENU



SERVICE LEVEL SPECIFICATION FOR COST MODEL

SCREEN DESCRIPTION:

Service level specification

WHAT TO DO:

Enter up to 8 service types and up to 7 assignment variables for the BASE YEAR. Also enter the values of assignment variable X for service type Y. You can also enter the service level for up to 5 more future dates.

HOW TO DO:

Use the arrow keys to move to the desired field and type in the text or value. You can press the F9 key to enter data for the next date. The new date appears at the top of the screen. Assignment variables can be defined within the boxes in the first row.

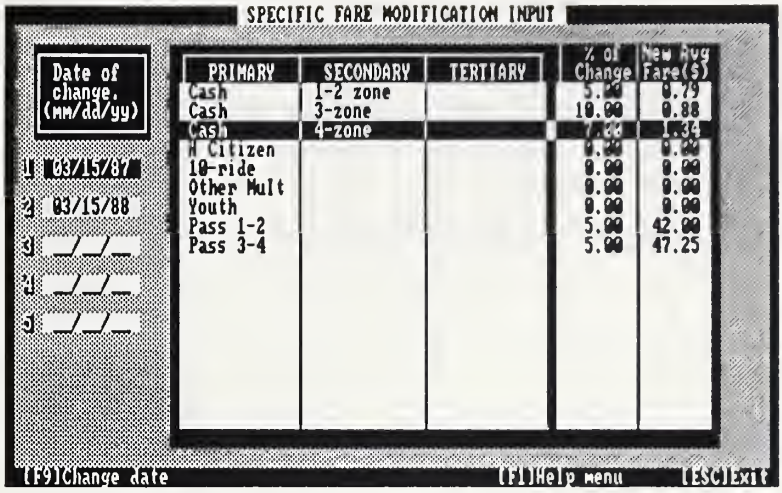
COMMENTS:

The cursor will only move down to the next TYPE OF SERVICE only if a service type is entered. The same goes for moving the cursor to the next column. That is, an ASSIGNMENT VARIABLE must be entered before the cursor can move one more column to the right. This feature was built in so that you will not leave blank service types at the top. All service types should be at the top of the 8 rows. Do not, for example, enter a service type in the first row, leave the next row blank and enter another in the 3rd row. Do not leave blank columns either within the list of ASSIGNMENT VARIABLES.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field.
F1	Shows the HELP MENU.
F9	To enter data for another date. (Up to 5 other dates)
F10	Moves the cursor to the date field at the top.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data for the numeric fields.
anytext	Valid input data for the SERVICE TYPE & ASSIGN. VAR.

ESC Exit the screen.

PREVIOUS SCREEN: COST MODEL INPUT MENU



SPECIFIC FARE MODIFICATION INPUT

SCREEN DESCRIPTION:

Specific FARE modification for each category.

WHAT TO DO:

Enter up to 5 percentage changes and the date to take effect after the BASE MONTH for each category. That is, for each date, you can make fare changes for each category. You have the option of entering the % change or the new avg. fare. Whichever is entered, the other column will automatically change also. For example, if the BASE fare of a category was 1.00 and a % change of 10.0 was entered, then the new avg. fare column would automatically read 1.10.

HOW TO DO:

Type in the date that the change is to take place being sure to use leading 0's. If the date is invalid, then the date field is blanked out until a valid date is entered. Next, enter the percentage net change (Positive or negative) or the new avg. fare (in $) for each category for that date. To move to the next date, press the F9 key.

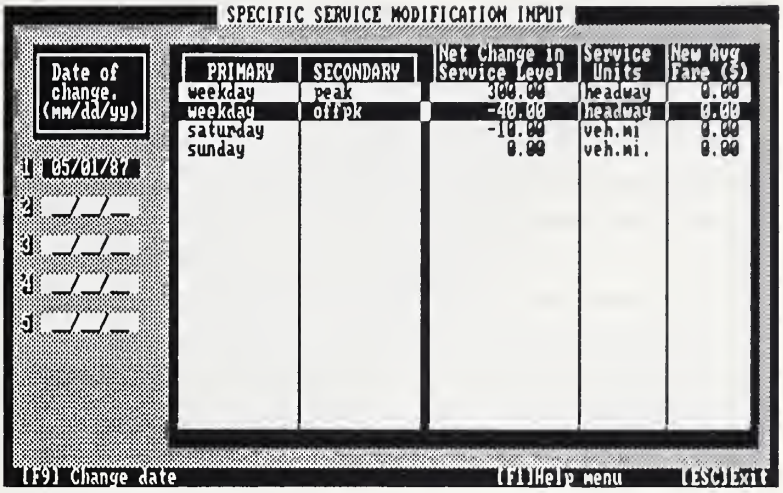
COMMENTS:

All dates entered must be from lowest to highest. For example, the date entered in position 4 should be a later date than the one entered in 2 and 3, and likewise earlier than 5,6,7, and 8. Also, there can not be any blank rows between dates. That is, do not enter a date in position 1,2, and 4 and leave position 3 blank. Fill positions 1,2, and 3.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field. The date field will be blanked out if it is not a valid one.
F1	Shows the HELP MENU.
F9	To make service modifications at another date.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.

-,+	Negative or Positive % change.
ESC	Exit the screen.

PREVIOUS SCREEN: FARE MODIFICATION INPUT MENU



SPECIFIC SERVICE MODIFICATION INPUT

SCREEN DESCRIPTION:

Specific service modification for each category.

WHAT TO DO:

Enter up to 8 service level changes and the date to take effect after the BASE MONTH for each category. The New Avg. Fare column is optional but can be entered if the user knows the exact average fare for that particular service level and category change.

HOW TO DO:

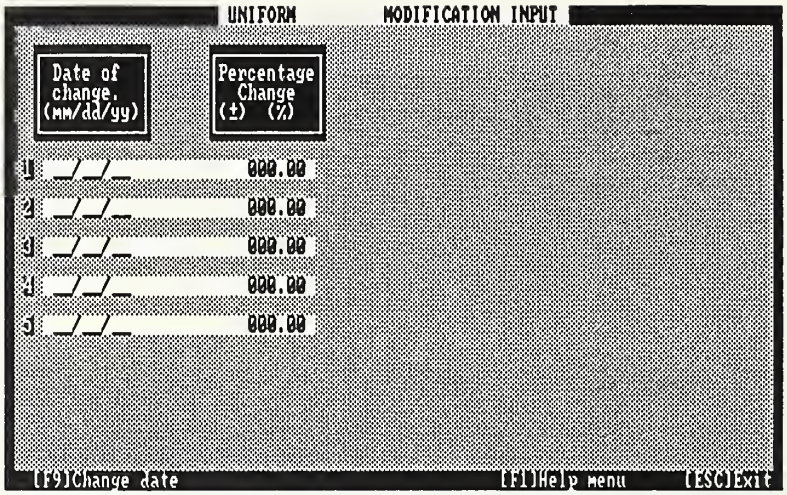
Type in the date that the change is to take place being sure to use leading 0's. If the date is invalid, then the date field is blanked out until a valid date is entered. Next, enter the net change (Positive or negative) for each category for that date. To move to the next date, press the F9 key.

COMMENTS:

All dates entered must be from lowest to highest. For example, the date entered in position 4 should be a later date than the one entered in 2 and 3. Also, there can not be any blank rows between dates. That is, do not enter a date in position 1,2, and 4 and leave position 3 blank. Fill positions 1,2, and 3.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field. The date field will be blanked out if it is not a valid one.
F1	Shows the HELP MENU.
F9	To make service modifications at another date.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
-,+	Negative or Positive net change.
ESC	Exit the screen.

PREVIOUS SCREEN: SERVICE INPUT MENU



UNIFORM MODIFICATION INPUT

SCREEN DESCRIPTION:

Uniform modification input screen.

WHAT TO DO:

Enter up to 8 percentage changes and the dates in which they will take effect after the BASE MONTH.

HOW TO DO:

Type in the date that the change is to take place being sure to use leading 0's. If the date is invalid, then the date field is blanked out until a valid date is entered. Next, enter the percentage of change (Positive or negative) for that date. To move to the next date, press the F9 key.

COMMENTS:

None.

KEY	FUNCTION
ARROWS	Formats the field entered, then moves the cursor to another field. The date field will be blanked out if it is not a valid one.
F1	Shows the HELP MENU.
F9	Moves highlight bar to the next date.
RETURN	Same as the RIGHT arrow key.
BACKSP	Backspaces a character within a field.
0-9,.	Valid input data.
-,+	Negative or Positive % change.
ESC	Exit the screen.

PREVIOUS SCREEN: FARE MODIFICATION INPUT MENU

CHAPTER 3: REPORTS

REPORTS

The ITPE program can generate many different types of reports. The screen that lets you specify these reports is the SELECT REPORTS screen. You can have it output FARE, SERVICE, or SYSTEM CHANGE either in terms of TRIPS or REVENUE, and tabulate that data either MONTHLY, QUARTERLY, or YEARLY. Below are two example outputs:

1987 QUARTERLY FARE CHANGE IN TRIPS

	JAN-MAR	APR-JUN	JUL-SEP	OCT-DEC
Cash\1-2 zone	18.20	-222.46	-850.33	-843.98
Cash\3-zone	6.22	-76.03	-290.63	-288.46
Cash\4-zone	2.16	-26.37	-100.78	-100.03
H Citizen	3.18	-103.11	-153.35	-149.68
10-ride	10.85	-133.99	-515.18	-505.20
Other Mult	7.44	-90.33	-348.97	-340.18
Youth	12.31	-394.44	-584.02	-574.28
Pass 1-2				
.....Diverted users:	-0.00	-0.00	-0.00	-0.00
.....Induced users:	0.38	-12.17	-18.19	-17.65
.....Total users:	0.38	-12.17	-18.19	-17.65
Pass 3-4				
.....Diverted users:	-3.31	-5.13	-5.40	-5.46
.....Induced users:	0.15	-4.97	-7.43	-7.20
.....Total users:	-3.15	-10.10	-12.83	-12.67

1987 MONTHLY SYSTEM CHANGE IN TRIPS

	JAN	FEB	MAR	APR	MAY	JUN
GROWTH EFFECT	7.68	15.36	23.04	30.72	38.41	46.10
SEASONALITY EFFECT	1515.38	1212.61	303.23	909.92	606.77	-910.38
FARE CHANGE	14.48	28.94	43.27	57.85	-837.97	-1114.88
SERVICE CHANGE	0.00	0.00	0.00	0.00	331.18	917.28
AUTO COST CHANGE	144.82	143.48	139.38	142.17	140.83	133.96
TOTAL CHANGE	1682.37	1400.39	508.91	1140.67	279.22	-927.92
BASE TRIPS	30300.00	30300.00	30300.00	30300.00	30300.00	30300.00
NEW TRIPS	31982.37	31700.39	30808.91	31440.67	30579.22	29372.08

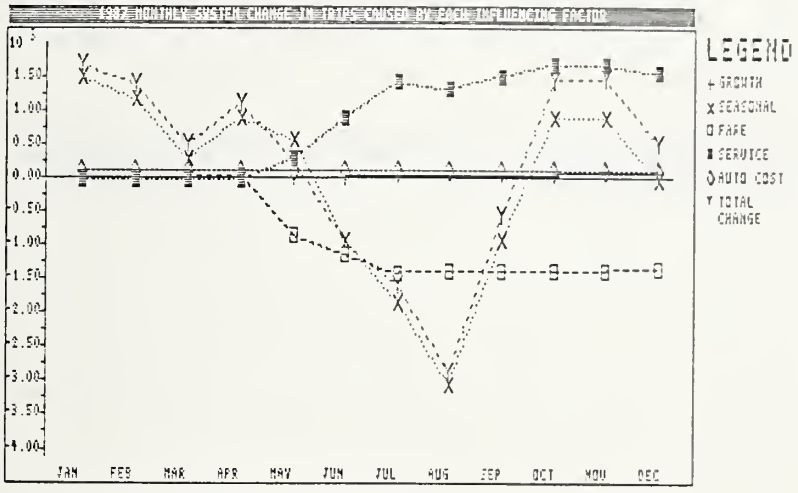
The top table is an example of what the SERVICE or FARE display would look like. All of the categories defined would be outputted and all pass categories would be expanded as shown.

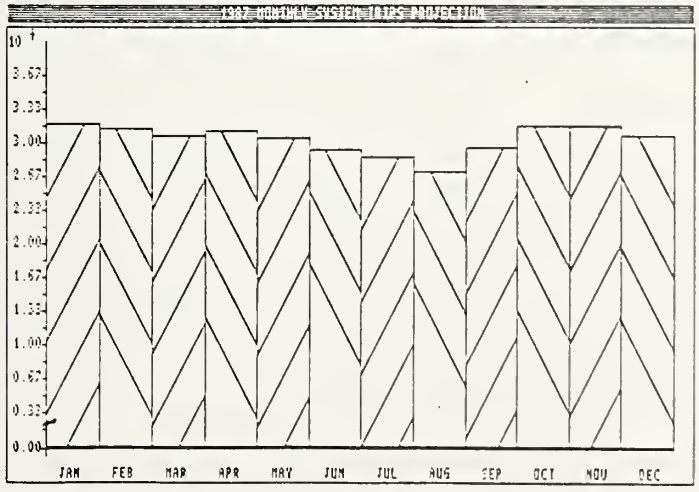
The bottom table is an example of what the SYSTEM display would look like. The TOTAL CHANGE is the sum of the first 5 factors, and NEW TRIPS is the sum of BASE TRIPS and TOTAL CHANGE.

It is also possible to output the SYSTEM change graphically in two ways. One type of graph is a line graph of the 6 items that are listed in the second table above, namely, the GROWTH effect, SEASONALITY effect, FARE change, SERVICE change, AUTO COST change, and TOTAL change. This graph can also be in terms of TRIPS or REVENUE expressed MONTHLY, QUARTERLY, or YEARLY.

The second graph is the NEW TRIPS or REVENUE as a result of the 6 individual changes. This is displayed as a BAR graph.

Below are examples of the two graphs:





All tabular and graphical output can be sent either to the screen, printer, or file. See the section on HARDWARE OPTIONS if you want to send graphs to the screen or printer.

CHAPTER 4: POLICY EVALUATION

POLICY EVALUATION REPORTS

The policy evaluation module consists of generating reports on various performance measures of a pricing policy. The screen that lets you specify these reports is the PRICING POLICY EVALUATION OUTPUT screen. The tabular output can be in terms of REVENUE, COST, TRIPS, REVENUE/TRIPS, COST/TRIPS, or REVENUE/COST.

The columns of each table are yearly values, where the starting year is the base year that was initially input in the FARE/REVENUE BASE DATA INPUT screen. Since the model can produce up to 5 years of forecast, there can be up to 5 columns.

The rows of each table can be stratified either by fare categories, systemwide (the sum of all fare categories for a year), or by service type (Service types as defined under the cost input module). The cost input module is where up to 8 service types can be defined and where each fare category is assigned to a particular service type).

One last feature is the RAMSEY PRICING output by fare categories. This particular output helps the user to compare the proposed (or existing) pricing structure with that of the estimated economically efficient pricing structure (i.e. Ramsey Prices). For a realistic analysis, the ITPE Model permits an estimation of both constrained and unconstrained values of the Ramsey prices. Therefore, choosing this option will present another submenu where one can set any desired constraints. For this submenu, you can either choose to output the new Ramsey prices or you can set your own constraints such as maximum fare limits and/or annual subsidy levels. The maximum fare limit feature is especially meant for those fare groups which are generally subsidized (For details, see Chapter 5).

CHAPTER 5: METHODOLOGY

Introduction

The ITPE model consists of three submodels: the disaggregate elasticity model for ridership and revenue forecasting (DELREV), a cost model, and a pricing policy evaluation model. Each of these three submodels are briefly discussed below.

Disaggregate Elasticity Model for Ridership/Revenue Forecasting (DELREV)

The Disaggregate Elasticity Model for ridership and revenue prediction is the basic component of the ITPE (Interactive Transit Pricing Evaluation) Model. It is a monthly ridership and fare revenue forecasting model which incorporates the effects of demographic changes, seasonality, inflation, change in auto cost of travel, time lag of fare- and service-change effects as well as the implications of ridership shifts between cash fare and prepayment fare categories.

For each month, the DELREV model predicts separately the changes in ridership and resulting fare revenue caused by growth, seasonality, fare and service changes, and auto cost of travel in a stepwise sequential manner as shown in Figure 5.1. The model operates on the assumption that the overall patronage response is the sum of mutually independent marginal changes in the ridership caused by each factor. The rationale for this particular sequential structure is mainly conditioned by the logic of computation; no theoretical evidence is available which suggests any particular order concerning the inclusion of these factors.

Each of the seven computational steps, shown in Figure 5.1, are briefly explained below:

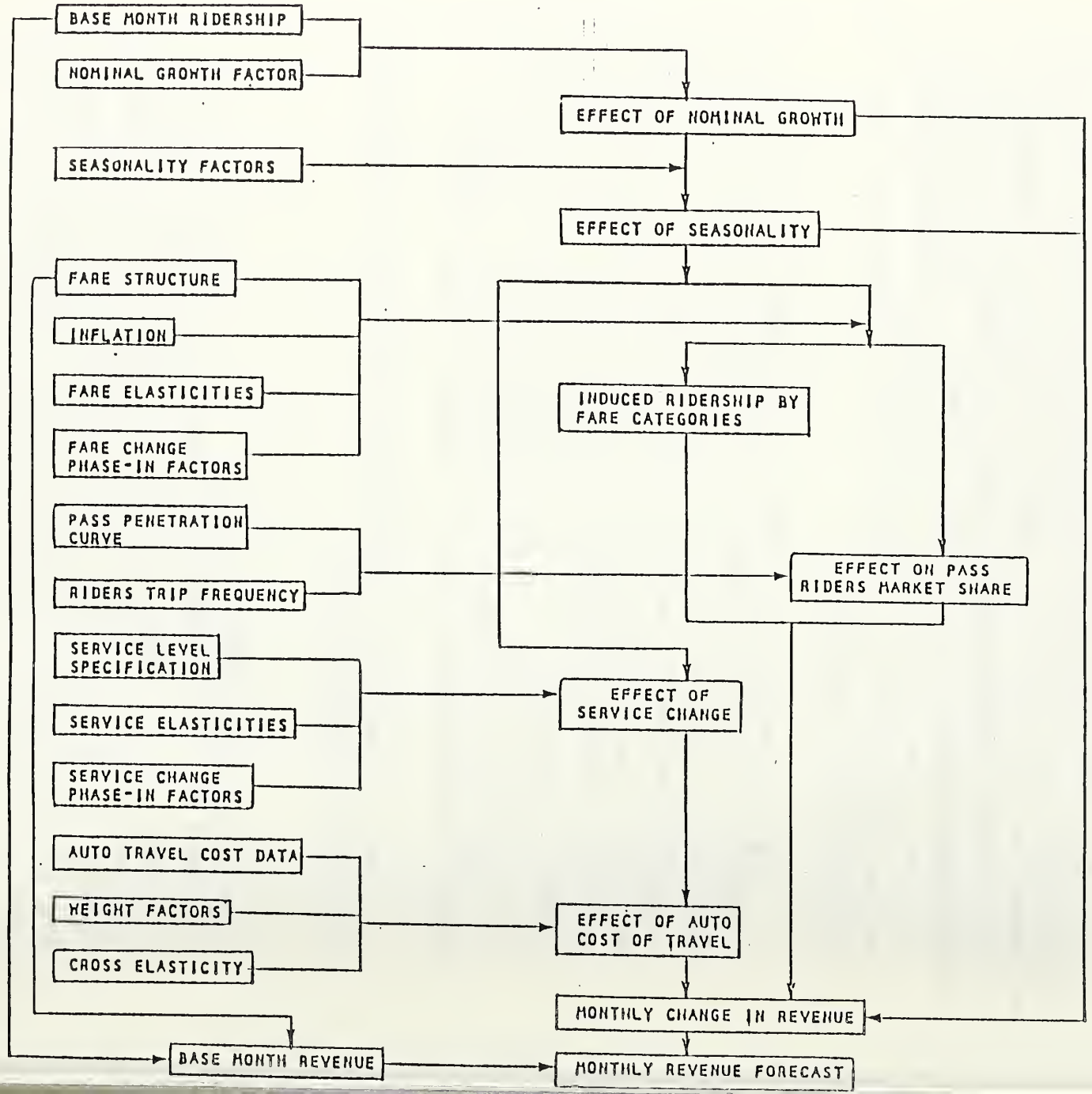
Step 1: Base Month Ridership Input

Base Month Ridership (BMR) is the initial input furnished by the user. It is computed either by adjusting the ridership of the last month of the base year for seasonality, or by taking the average of the base year monthly ridership after incorporating the year-end effects of nominal growth, seasonality, change in auto cost of travel, and fare and service changes for each month.

In cases where overall effect of each influencing factor has been realized before the end of the base year, the former

INPUT

Figure 5.1: Estimating Changes in Ridership/Revenue



approach can be applied for the estimation of BMR, as expressed below:

$$BMR = TRIP_m / SF_m \qquad (5.1)$$

where;

$TRIP_m$ = Overall ridership during the month m (here, m refers to the last month of the base year)

SF_m = Seasonality factor for the month m

$= 12 * TRIP_m / \sum_{m=1} TRIP_m$

The BMR would remain constant in every future month if no change occurred in the influencing factors. Therefore, all base year end effects should be incorporated for the estimation of the BMR before using it for forecasting. For this purpose, first the remaining full or partial effects of changes in fare, service and auto cost of travel should be removed from all base year months. The next step is to include the full effects of all factors in each month as expressed below:

$$BMR = \frac{1}{12} * \sum_{m=1}^{12} \left\{ (TRIP_m/SF_m) * (GF_m)^{12-m} + \ldots \right.$$
$$\left. TRIP_{fm} + TRIP_{sm} + TRIP_{am} \right\} \qquad (5.2)$$

where;

TRIPm = Ridership of base year month m after removing effects of changes in fare, service and auto cost of travel.

GF_m = Growth Factor for the month m.

$\Delta TRIP_{fm}$ = Change in ridership caused by the full effect of a fare change during the month m.

f, s, a = Subscripts representing fare, service and auto cost of travel respectively.

Mathematical expressions for the estimation of ridership changes (ΔTRIP) due to the variation in fare, service and auto cost of travel are discussed under Steps 4, 6 and 7 respectively.

Step 2: Estimating the Effect of Nominal Growth

The base month ridership is first adjusted to include the effects of user-supplied annual nominal growth factors. These factors account for all the exogenous influences on ridership which can not easily be modelled, such as fluctuations in demographic variables, employment, labor participation rate, etc. In other words, the nominal growth factor takes into account the expected ridership trend (i.e., percentage annual growth or decline in ridership) caused by factors other than seasonality, changes in fare or service levels, and auto costs.

Simply by comparing the observed differences both in ridership and in a pre-defined demographic variable, i.e., service area population, for each base year month with that of the same month in the previous year, an analyst can determine several monthly impact factors. Analogous to the elasticity concept, an impact factor can be defined as the percentage change in ridership caused by a one percent change in the demographic variable (i.e., population). The average mean value of the monthly impact factors multiplied by the base year annual growth in the demographic variable provides the base year nominal growth factor. Only months with no effect on changes in fare and/or service levels should be included in such an analysis. For further sophistication, the user may wish to use simple regression analysis for the estimation of an impact factor.

The annual growth factor for each forecast year is input by the user. The DELREV model spreads this annual factor uniformly over all months in that year. The effect of nominal growth on ridership is estimated as follows:

$$GTRIP_m = BMR * (1 + GF)^{1/12} \quad (5.3)$$

$$GF = IF * (DF_y/DF_{y-1} - 1) \quad (5.4)$$

As mentioned above, monthly impact factors (IF_m) can be estimated using past ridership data and the following expressions:

$$IF = ((TRIP_{ym}/TRIP_{(y-1)m}) - 1) / ((DF_y/DF_{(y-1)m}) - 1) \quad (5.5)$$

$$\Delta GTRIP_m = GTRIP_m - BMR \quad (5.6)$$

where;

$GTRIP_m$ = Growth adjusted monthly ridership for month m

GF = Annual growth factor

IF = Ridership impact factor

DF_y = Demographic variable value for the year y (e.g., employment, population)

$TRIP_{ym}$ = Observed ridership during month m of year y

Step 3: Estimating the Effects of Seasonality on Each Fare/Trips Category

In this step, the growth-adjusted ridership is modified by multiplying a monthly seasonality factor input to reflect the seasonal variation in ridership. The seasonality factor includes the influence of number of working and non-working days per month as well as seasonal variations in weather condition. Since the seasonality effect may be more pronounced within certain markets of transit riders such as students, elderly/handicapped, and senior citizens, the model permits the user to specify seasonality factors for each predefined fare/trips category.

Seasonality factors can be determined from historical ridership data after removing the effects of major ridership-influencing factors such as fare and service changes, and nominal growth. The change in ridership due to growth and seasonality (ΔGSTRIP) in a month is estimated as follows:

$$GSTRIP_{im} = GTRIP_{im} * SF_{im} \quad (5.7)$$

$$\Delta GSTRIP_{im} = GSTRIP_{im} - BMR * PBTRIP_i/100 \quad (5.8)$$

where;

$GTRIP_{im}$ = Growth adjusted transit ridership of primary fare/trips category i during the month m

SF_{im} = Seasonality factor for the primary fare/trips category i during the month m

$PBTRIP_i$ = Percentage of base month ridership belonging to the primary fare category i.

Step 4: Estimating the Impacts of Cash Fare Changes

The net impact of fare changes on ridership by month is computed using the mid-point elasticity value for each user-defined fare-type category. The DELREV model computes ridership changes to the growth-and-seasonality-adjusted base month ridership of each fare category using the input elasticity value and inflation-adjusted fare level. Depending upon user-specified inputs, this step can be implemented at various levels of detail (i.e., primary, secondary, and tertiary categories of fare/trips).

The full effect of ridership change does not occur immediately as a result of a fare or service change; it phases in over a period of time. To incorporate the phase-in phenomenon for each user-specified fare and service category, the user has to input phase-in response time factors, which can be determined from the ridership response to past changes in fare or service. The model predicts the net change in monthly ridership by multiplying the response time factor of a specific fare/trips category to the estimated full impact of the fare change.

The general expression for the estimation of ridership by month for each fare/trips category ($TRIP_{ijkm}$) is as follows:

$$TRIP_{ijkm} = GSTRIP_{im} * PBTRIP_j/100 * PBTRIP_k/100 * \frac{2 * E_{ijk} (FARE_{ijkm} - BFARE_{ijk})}{FARE_{ijkm} * (1-E_{ijk}) + BFARE_{ijk} * (1 + E_{ijk})} * RTF_{ijm} \quad (5.9)$$

where;

$PBTRIP_j$ = Ridership market share (in %) of fare/trips category j

E = Fare elasticity of demand

BFARE = Base year fare level

RTF = Fare change response time factor (i.e. proportion of full response)

i, j, k = Subscripts representing three levels of fare/trips classification

Step 5: Predicting Pass Fare Plan(s) Market Share

In many transit agencies, fare prepayment plans such as unlimited use transit passes are part of the fare structure. There are also transit agencies currently without any prepayment fare plan who might consider introducing a pass in the future. With this view, the DELREV model has been designed with the option of evaluating both existing and new pass fare plan(s). Figure 5.2 illustrates the structure of the pass pricing evaluation part of the DELREV model.

As the main incentive of any pass fare plan is the level of discount it offers, the prediction of changes in revenue generation due to the diverted cash trips and induced ridership is fundamental to the pricing analysis. There will be two methodological options available to ITPE system users for the prediction of level of diversion of cash-fare riders to pass plan(s). Both approaches are based on the common notion of using a market pene-

tration curve(s), which simply represents the relationship between the market share of a pass plan (in %) and the level of discount it offers. Under the first option, the user will provide essential input pertaining to the use of the pass plan(s) at his/her agency or other agency to generate the pass fare market penetration curve(s). Under the second approach, an equation depicting the market penetration curve will be available as a default curve. Using data from 97 prepayment programs in the U.S., Ecosometrics Inc. has developed this particular equation (1).

The above methodological approaches will be available for the evaluation of both existing and proposed plans. A step-by-step evaluation procedure is discussed below for each type of plan (i.e., new or existing).

Option A: Evaluating Existing Pass Fare Plan(s)

Select Methodological Options

As mentioned earlier, there are two methodological options available for the evaluation of existing pass fare plan(s). Under the first option, the user has to input the necessary data for generating his/her own market penetration curve(s) as discussed below. However, in cases where data are either not available or incomplete for the application of the first option, a default market penetration equation can be utilized as discussed under option A.2.

Option A.1: Evaluating Existing Pass Fare Plan Using Market Penetration Curve Data

Step A.1.1: Identify Unlimited Use Pass Fare Categories

Although the model offers flexibility in defining the fare/trips groups, it is essential for it to know groups which are of unlimited use pass type.

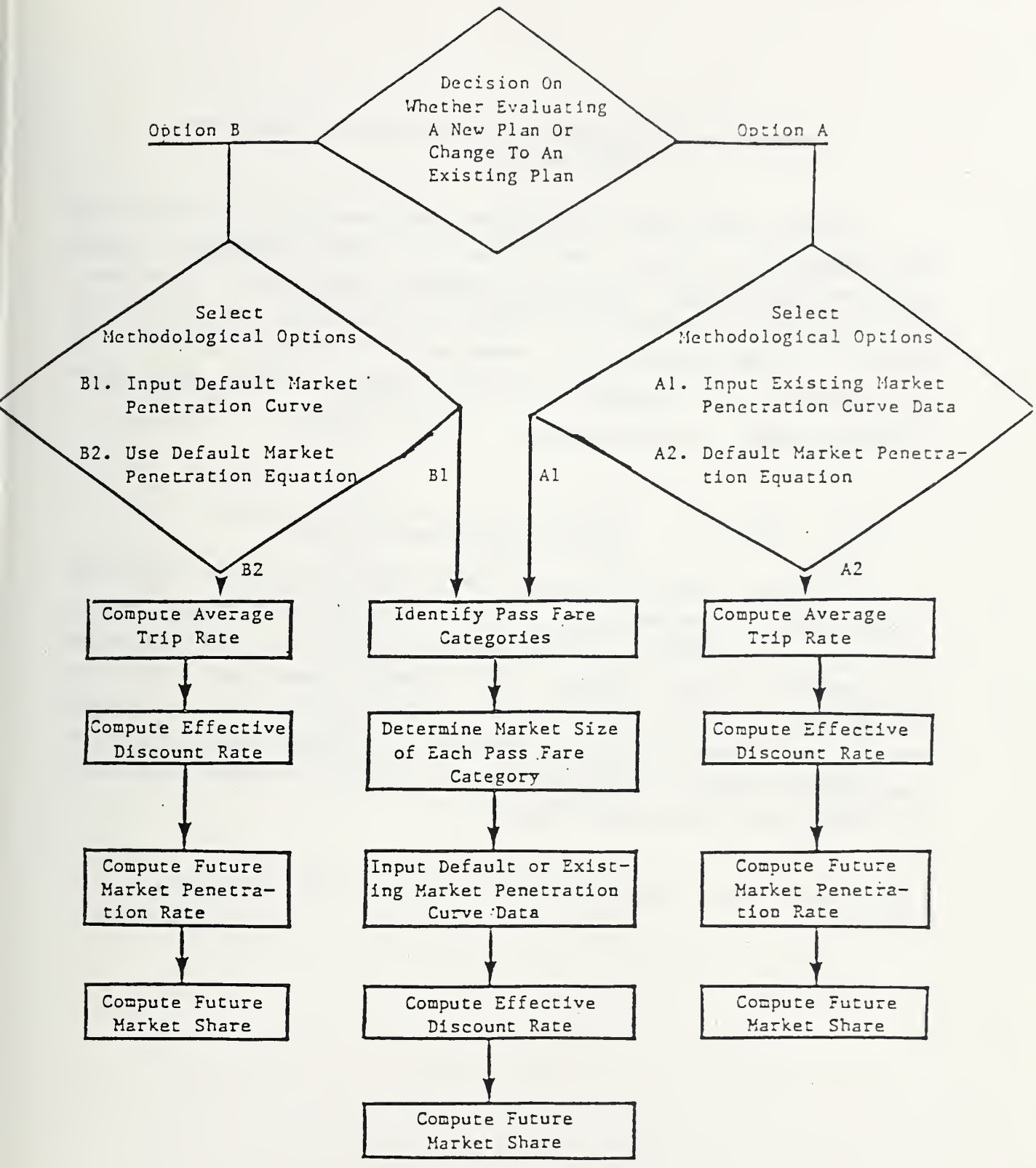


Figure 5.2: Flow Chart: Pass Fare Plan(s) Evaluation Model

Step A.1.2: Determine Market Size of Each Pass Fare Category

The pass use market considered here consists of those cash fare categories of riders which are identified as potential users of a particular type of pass in question. To define the market, the user has to indicate for each pass category (as defined in Step A.1.1) the corresponding competing cash fare categories. It is assumed that the pass categories don't compete with each other.

Step A.1.3: Input Default or Existing Market Penetration Curve(s) Data

The basic inputs for generating a pass penetration curve are cross tabulated survey results of weekly trip making and number of users from a defined market segment (Step A.1.2) classified by the methods of fare payment (for example, cash and pass fare categories). Table 5.1 illustrates the results of an on-board survey tabulated in the above manner. If there is more than one pass fare category, then the user can furnish the data separately for each pass users market segment.

Table 5.1

PASS PENETRATION CURVE DATA: AN EXAMPLE

Frequency Class	Range of Weekly Trips	Number of Transit Users*	% of Type "p" Pass Users
A	1-2	5588	6.07
B	2-4	6116	12.90
C	4-6	7457	25.37
D	6-8	7051	43.48
E	8-10	25452	72.18
F	10-12	7798	70.72
G	12-14	8418	65.08
H	14-16	4033	68.93
I	16-18	1815	76.14
J	> 18	15420	71.00

* Includes pass users and cash riders who have the option of using pass.

Step A.1.4: Compute Effective Discount Rate

For establishing the relationship between the level of discount and the market share of pass users, first the level of discount (DISC) offered to each type of pass fare plan buyers belonging to each user-defined trip frequency class is estimated in the following manner:

$$(DISC)_{pjfm} = \frac{AFARE^{op}_{ijm} - FARE_{pjm}/ATRIPS_{pjf}}{AFARE^{op}_{ijm}} \times 100 \qquad (5.10)$$

where;

$DISC_{pjfm}$ = Discount rate provided for the riders of monthly trip frequency class f buying pass fare plan p (p i) of the type j during the month m.

$AFARE^{op}_{ijm}$ = One way average fare for those cash fare categories which are considered to have an option(op) of buying pass p, j during the month m.

$ATRIPS_{pjf}$ = Average monthly trip making rate of pass buyers belonging to trip frequency class f and using pass p of type j.

Once the discount levels are estimated using the base month data, the model stores in memory the relationship between the discount and the corresponding market share of pass users (i.e., pass market penetration curve).

Step A.1.5: Compute Future Market Share

For each trip frequency class, the predicted number of users of a particular pass fare plan is determined by the model using the estimated discount rate (from the previous step) of that particular trip frequency class and the corresponding interpolated value of the market share (PUSER) read from the base month market penetration curve. The number of transit users

diverted to a prepayment fare category (DIVPUSERS) in each trip frequency class is then estimated by subtracting the existing or base month users (BPUSERS) from predicted number of pass users (PUSERS) as expressed below:

$$DIVPUSERS_{pjfm} = BPUSERS_{pjf} - PUSERS_{pjfm} \quad (5.11)$$

In addition to the diversion (positive or negative) from cash-fare categories, changes in the price of a pass plan may cause pass users to be induced from or lost to non-transit modes. Since this behavior is considered similar to that caused by a change in cash fare (as discussed earlier under Step 4), the DELREV model utilizes the concept of price elasticity as expressed below:

$$INPUSERSpjm = \frac{2 * (\sum_f BPUSERS_{pjf}) * E_{pj}(FARE_{pjm} - BFARE_{pj})}{FARE_{pjm}(1 - E_{pj}) + BFARE_{pj}(1 + E_{pj})} \quad (5.12)$$

The total change in the number of pass users (PUSERS) is estimated by summing the newly diverted cash riders (from Equation 5.11) and induced pass users (from Equation 5.12) as shown below:

$$\Delta PUSERS_{pjm} = \sum_f DIVPUSERS_{pjfm} + INPUSERS_{pjm} \quad (5.13)$$

$$\Delta PTRIP_{pjm} = \sum_f \frac{(DIVPUSERS_{pjfm} * ATRIP_{pjf}) + INPUSERS_{pjm} * ..}{ATRIP_{pj}} \quad (5.14)$$

The trip rate of new pass users has often been observed to increase since their marginal cost of making additional trips is zero. The model assumes that no change in the monthly trip rate of pass users occurs due to changes in the offered level of discount (of pass over cash). This may cause inaccuracies in the predicted patronage level, but will not affect overall revenue estimation. In addition, the model assumes that the induced

riders in both the cash and pass sub-markets do not move out of their respective categories.

Option A.2: Evaluating Existing Pass Fare Plan Using Default Market Penetration Equation

Step A.2.1: Compute Average Trip Rate

For an existing plan if the actual trip rate is known, then this value is input by the user. However, for those who do not have a reliable estimate of the existing average trip rate, either equation (5.23) or (5.24) can be utilized.

According to equations (5.23) and (5.24), the average trip rate of pass users is based, in part, on how the pass is priced relative to the average cash fare (i.e., break-even rate). Thus,with the changes in break-even rate, the average trip rate is expected to adjust upward or downward accordingly. The following expression derived by Ecosometrics (1) is utilized for the purpose of estimating the new average trip rate of a pass program (for detail see Appendix E):

$$ATRIPS_{pm} = BATRIPS_p + \frac{0.70\ (BKEVEN^2_m - BBKEVEN^2)}{\sqrt{6096 + 0.70\ (BBKEVEN + BKEVEN_m)^2}} \qquad (5.15)$$

where;

$BATRIPS_p$ = Base month average number of trips taken per month by pass holder.

$BKEVEN_m$ = Break-even rate during month m

BBKEVEN = Base month break-even rate

Step A.2.2: Compute Effective Discount Rate

Same as Step B.2.2.

Step A.2.3: Compute Future Market Penetration Rate

Based upon equation (5.25), the future market penetration rate can be estimated using the following expression (see Appendix E for the derivation):

$$PTRIPS_{pm} = BTRIPS_p * [1 + (0.0597)\ (1-BTRIPS_p)\ (\Delta DISC_{pm})] \quad (5.16)$$

where;

$\Delta DISC$ = Change in discount rate as a result of price change, expressed as a percentage. (i.e., $\Delta DISC_{pm} = DISC_{pm} - BDISC$).

$BTRIPS_p$ = Proportion of base month revenue passenger trips that are taken with the fare prepayment plan.

Step A.2.4: Compute Future Market Share

Prediction of ridership level as a result of new price of existing pass program becomes complex as prices can either increase or decrease relative to the cash fare. If prices decrease, trips will be diverted from cash and new trips will be generated. On the other hand, if prices increase some existing pass trips will be lost and others will be diverted back to cash. Figure 5.3 illustrates the direction of these ridership changes. Ridership calculations for the above said two conditions are as follows:

Decrease in the Price of Pass Plan

If the price of the pass fare plan is decreased relative to the average cash fare, the number of diverted cash trips can be

estimated from the following equation (see for detail Appendix E):

$$DIVTRIPS_{pm} = \frac{GSTRIPS_m * PTRIPS_{pm}}{1-E_p * (\Delta DISC_{pm}/(100-BDISC_p))\ (1-PTRIPS_{pm})} - BTRIPS_p \quad (5.17)$$

The number of trips generated by the discount can be computed from the total population of trips affected by the discount, namely:

$$NTRIPS_{pm} = -(BTRIPS_p + DIVTRIPS_{pm})(E_p)(\Delta DISC_{pm}/(100-BDISC_p)) \quad (5.18)$$

Total prepaid trips during the month m can be computed as shown below:

$$TRIPS_{pm} = BTRIPS_p + DIVTRIPS_{pm} + NTRIPS_{pm} \quad (5.19)$$

Increase in the Price of Prepayment Plan

If the price of the pass fare plan is increased relative to the average cash fare, future pass trips will decrease due to a loss in marginal trips and diversion of pass trips to cash fare categories. The number of trips diverted from pass to cash can be estimated from the following expression (for detail see Appendix E):

$$DIVTRIPS_{pm} = BTRIPS_p\ [1-(E_p)(\Delta DISC/(100-BDISC_p)(1-PTRIPS_{pm})] - GSTRIPS_m * PTRIPS_{pm} \quad (5.20)$$

Since $DISC_{pm}$ is less than BDISC, ΔDISC (i.e., $DISC_{pm}$ - BDISC) is a negative quantity.

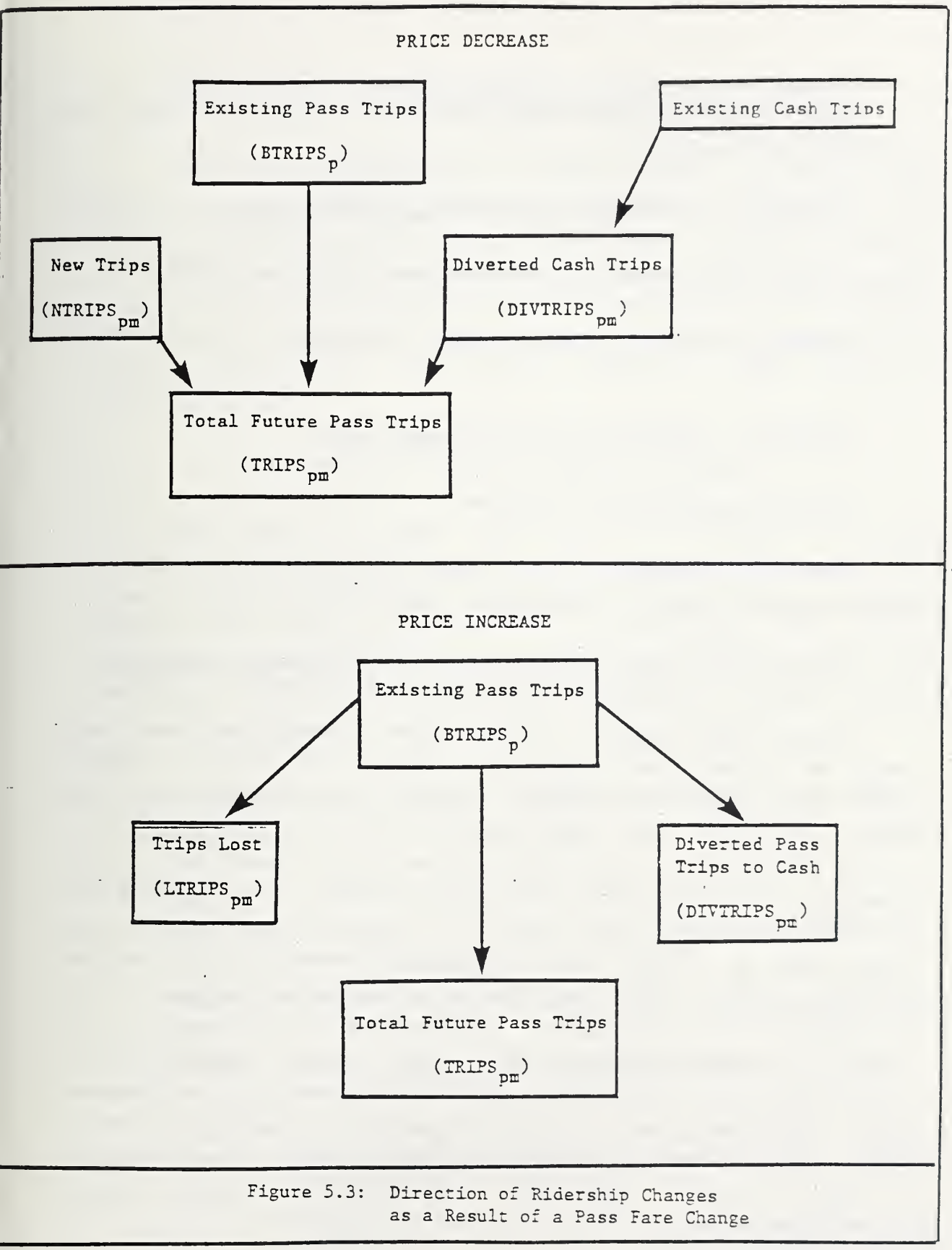


Figure 5.3: Direction of Ridership Changes as a Result of a Pass Fare Change

The number of lost pass ridership is estimated using the equation shown below:

$$LTRIPS_{pm} = (BTRIPS_p)\ (E_p)\ (\Delta DISC_{pm}/(100-BDISC_p) \qquad (5.21)$$

Total predicted prepaid trips during the month m will be:

$$TRIPS_{pm} = BTRIPS_p - DIVTRIPS_{pm} - LTRIPS_{pm} \qquad (5.22)$$

Option B: Evaluating New Prepayment Plan

Select Methodological Options

For the evaluation of new pass fare plan(s), there are two methodological options available to the users.

Option B.1: Evaluating New Pass Fare Plan Using Default Market Penetration Curve(s) Data

Under this option, a pass market penetration curve data could be transferred from another agency and input in tabular form. This table will consist of only two columns; under the first column the user should specify various values of discount (in %) whereas the corresponding market size of pass users (in %) should be indicated under the second column. By applying the procedure described under step A.1.4, one can easily generate the above form of a table from the on-board survey data of another transit agency. The remaining computation pertaining to the evaluation of the pass plan(s) is analogous to the steps A.1.1 to A.1.5. A user can either enter data for one general default penetration curve or several curves for each type of proposed pass categories (i.e., up to eight tables). However, in either case, the user has to indicate the market size of each category of pass plan(s) and their corresponding default market penetration curve.

Option B.2: Evaluating New Pass Fare Plan Using Default Market Penetration Equation

Under the second option, a default market penetration equation is made available for the application. Since the 97 cases used to calibrate the equation are adult, general population student passes or off-peak shopper plans, this equation should only be utilized to estimate the percentage of all revenue passengers that would use a fare prepayment plan once the program is fully established. All steps related to this option are described below.

Step B.2.1: Compute Average Trip Rate

The number of trips taken per pass instrument by transit riders is an essential input for the estimation of level of discount offered and in turn, its market penetration rate. In cases where this average trip rate is not available, the following expression developed on the trip rate experiences of 23 transit companies (1) can be utilized for forecasting average trip rate of pass plan buyers:

$$\ln ATRIPSp = 3.7619 + 0.0829 \ln (VMILES/PBRATIO) + 0.0898(DBK) \quad (5.23)$$

where;

ln = Natural logarithm

ATRIPS = Average number of trips taken per month per pass holder.

VMILES = Total number of annual vehicle revenue miles of service provided in millions.

PBRATIO = Ratio of the number of revenue vehicles operated during the peak to the number of revenue vehicles operated during the base.

DBK = Summary variable for the monthly break-even rate which takes on a value of 1 if the actual equiva-

lent break-even rate is greater than or equal to 40 one-way trips per month, or 0 if the actual equivalent break-even rate is less than 40 one-way trips per month.

However, for small transit properties operating less than one million revenue vehicle miles of service annually, the above study suggests the following simpler expression:

$$ATRIPS_p = 1.15 * BKEVEN \quad (5.24)$$

where;

$ATRIPS_p$ = Average number of trips taken per month per pass holder.

BKEVEN = Actual break-even rate of the pass plan.

Step B.2.2: Compute Effective Discount Rate

For the known average trip rate, the level of discount is computed using equation 5.9. This methodology is especially meant for estimating system-wide share of the trips taken by pass plan users for an estimated value of the discount.

Step B.2.3: Compute Future Market Penetration Rate

In order to predict the percentage of revenue passengers using the proposed (or existing for the users of option A.2) pass plan, the following market penetration curve equation is utilized:

$$\ln \frac{PTRIPS_{pm}}{1-PTRIPS_{pm}} = -1.1469 + 0.0597\ DISC_{pm} - 0.3874\ \ln ATRIPS_{pm} - 0.2596\ COMP_m + 0.0047\ OUTLETS_m \quad (5.25)$$

where;

$PTRIPS_{pm}$ = Proportion of total revenue passenger trips that will be taken with the fare prepayment plan

during the month m, expressed as a decimal fraction.

DISC = Actual or average discount rate provided for fare prepayment buyers, expressed in percentage as given by the expression 5.9 (i.e., Step B.2.2).

ATRIPS = Average number of trips that are taken with the fare prepayment plan (i.e., Step B.2.1).

OUTLETS = Number of fare prepayment sales outlets.

COMP = Total number of different fare prepayment plans that are available to revenue passengers.

The above model was developed by Ecosometrics, Inc.(1), using cross sectional data from 97 transit fare prepayment programs across the country. From the above equation, $PTRIPS_{pm}$ is estimated as follows:

$$PTRIPS_{pm} = \frac{e_m^u}{1 + e_m^u} \qquad (5.26)$$

where;

u represents right hand side of the equation (5.24).

Step B.2.4: Compute Future Market Share

In general, fare prepayment users behave in the same way as cash users if the cost of riding is reduced. Therefore, the ridership response to the introduction of new prepayment plans (pass or ticket) is analyzed in a way similar to that used to estimate the ridership impacts of fare changes. It is widely believed that the introduction of a new pass plan will have negligible effect on attracting new riders to the system. However, both frequent and infrequent riders are expected to ride more often if some discount is provided. That means, there will be new transit rides instead of new riders.

To estimate total number of prepayment users trips, first those trips that will be diverted from cash or other existing prepayment plans to the new prepayment plan is computed using the following expression:

$$DIVTRIPS_{pm} = \frac{GSTRIP_m * PTRIPS_{pm}}{1-E_p\ (DISC_{pm}/100)\ (1-PTRIPS_{pm})} \qquad (5.27)$$

The formula for computing the number of new transit trips (NTRIPS) is as follows:

$$NTRIPS_{pm} = -(DIVTRIPS_{pm}) * E_p * (DISC_{pm}/100) \qquad (5.28)$$

The total number of prepaid one-way trips can be computed as follows:

$$TRIP_{pm} = DIVTRIPS_{pm} + NTRIPS_{pm} \qquad (5.29)$$

Step 6: Estimating the Impact of Service Changes

In this step, the net impact of service changes on ridership is calculated for each user-defined category of transit service, e.g., express, peak/off-peak, CBD routes, etc. The model permits two level segmentation for the specification of service categories. The impact of the proposed changes in service units can be estimated by either of two ways; the service elasticity-based method or service-productivity-based method. In a manner similar to fare changes, the full effect of service change on the ridership level is phased over a period of time. The model assumes that implications of service change are additive in nature, and incremental riders from service changes do not necessarily respond to cost changes (fare and/or auto).

The expressions used for estimating the impact of a service change are as follows:

Service Elasticity Based Method

$$\Delta TRIP_{rsm} = \frac{2E_{rs} * \Delta SERV_{rsm} * RTS_{rsm}}{2BSERV * PBSERV_{rs}/100 + \Delta SERV_{rsm} * (1-E_{rs})} \quad (5.30)$$

where;

$\Delta TRIP_{rsm}$ = Change in ridership level of service category r of rsm type s during the month m

RTS = Service change response time factor

$\Delta SERV_{rsm}$ = Change in service supply level

BSERV = Base month total service supply level

$PBSERV_{rs}$ = Proportion of base month service level in the service category r of type s

E_{rs} = Service elasticity of category r of type s

Service Productivity Based Method

The full change in monthly riders is estimated by calculating the product of the specified net change in monthly service units (e.g., revenue hours, platform hours, vehicle miles, etc.) and passengers per service unit (i.e., service productivity) for each category of service. To reflect the time lag in ridership response by month, the full monthly impact is modified by multiplying the response time factor as shown in the following expression:

$$\Delta TRIP_{rsm} = \Delta SERV_{rsm} * SPROD_{rs} * RTS_{rsm} \quad (5.31)$$

where;

$SPROD_{rs}$ = Service productivity (i.e., passengers/service unit) of service category r of type s

Step 7: Estimating the Impact of Change in Auto Cost of Travel

Under this step, the impact of an increase or decrease in auto operating cost per mile relative to the transit fare per mile is estimated. Using the notion of cross-elasticity, the annualized change in ridership is first estimated. Then, it is distributed equally amongst each month utilizing a standard compounding formula. The average auto operating cost per mile considered here is the weighted sum of the gasoline cost per mile and parking cost per mile.

The model permits the stratification of the overall travel market into up to eight groups. This feature helps to incorporate the spatial differences in the auto cost of travel mainly caused by the variation in parking fees at each location (e.g., CBD oriented travel, certain suburban-activity-center oriented trips, etc).

The procedure discussed above can be expressed as follows:

$$ACOST_{ay} = PWT_{ay} * (PC_{ay}/TL_{ay}) + GWT_{ay} * GCM_{y} \quad (5.32)$$

$$TRIP_{m}^{auto} = GSTRIP_{im} * PTRIP_{a}/100 * (CE_{a} * ((ACOST_{ay} - ACOST_{base})/ACOST_{base})) \quad (5.33)$$

where;

$ACOST_{ay}$ = Average auto cost of travel for the travel market a

PWT = Parking weight factor

PC_{ay} = Average parking cost for the travel market a during the year y

TL = Average auto trip length

CE_{a} = Cross elasticity of the market group a with respect to auto cost of travel

$PTRIP_a$ = Percentage of base month trips belonging to market group a

$TRIP_m^{auto}$ = Change in monthly riders due to auto cost during the month m

GCM = Gasoline cost per mile during the year y

GWT = Gasoline weighting factor

Step 8: Estimating Overall Change in Ridership

By aggregating the output of all previous steps, the system-wide change in ridership is estimated as shown below:

$$\Delta TRIP_m = \underset{(5.8)}{GSTRIP_m} + \underset{(5.9)}{\sum_i \sum_j \sum_k \Delta TRIP_{ijkm}} + \underset{(5.14)}{\sum_j \Delta PTRIP_{pjm}}$$

$$(\text{or}, \quad \underset{(5.22 \text{ or } 5.29)}{(TRIPS_{pm} - BTRIPS_p))} + \underset{(5.30 \text{ or } 5.37)}{\sum_r \sum_s \Delta TRIP_{rsm}} + \Delta TRIP_m^{auto}$$

(5.34)

(5.35)

Step 9: Estimating Passenger Revenue

The DELREV generates system-wide losses and gains in revenue by summing up the marginal effects in previous steps for nominal growth, seasonality, cash fare changes, changes in pass users market share (if there is a pass program), service changes and change in auto cost of travel. These outputs are produced for each month, along with yearly totals for the entire forecasting period of five years. Revenue prediction takes into account the losses caused by the discount provided to cash riders diverted to pass.

Change in monthly revenue due to the nominal growth:

$$\Delta GREV_m = \Delta GTRIP_m * AFARE_m \quad (5.36)$$

Change in monthly revenue due to the seasonality effect:

$$\Delta SREV_m = (\Delta GSTRIP_m - \Delta GTRIP_m) * AFARE \quad (5.37)$$

Change in monthly revenue caused by the fare change:

$$\Delta FAREREV_m = \sum_i \sum_j \sum_k \Delta TRIP_{ijkm} * FARE_{ijkm} \quad (5.38)$$

Change in monthly revenue due to the pass sales:

$$\Delta FAREREV_{pm} = \sum_j BTRIPS_{pj} * (FARE_{pjm} - BFARE_{pj})/ATRIPS_{pj} + \sum_j ((\Delta PTRIPS_{pjm}/ATRIPS_{pjm}) * FARE_{pjm}) + \sum_j AFARE^{op}_{pjm} * (-\Delta PTRIPS_{pjm}) \quad (5.39)$$

Change in monthly revenue due to the service change:

$$SERVREV_m = \sum_r \sum_s \Delta TRIP_{rsm} * FARE_{rsm} \quad (5.40)$$

Change in monthly revenue due to the auto cost of travel:

$$\Delta AREV_m = \Delta TRIP^{auto}_m * AFARE_m \quad (5.41)$$

Systemwide monthly fare revenue change:

$$\Delta REV_m = \Delta GREV_m + \Delta SREVm + \Delta FAREREV_m + \Delta FAREREV_{pm} + \Delta SERVREV_m + \Delta AREV_m \quad (5.42)$$

SENSITIVITY SELECTOR

Purpose

The Interactive Transit Pricing Evaluation (ITPE) model is based primarily on the notion of disaggregate fare and service elasticities. In order to estimate the sensitivity of ridership in each user-defined submarket to fare and/or service changes, the user has to input elasticity values for both fare and service. In many cases, elasticity values for the desired level of stratification are not available within a transit agency. Particularly for the evaluation of policies concerning differential pricing (peak/off-peak, distance based, service based, etc.) and specific kinds of service planning, disaggregate elasticities may be difficult to find. In such situations, one has to either transfer observed elasticity value(s) from other locations or assume these values based on personal judgement. In both cases, a user wishes to have quick access to the experience of other transit properties.

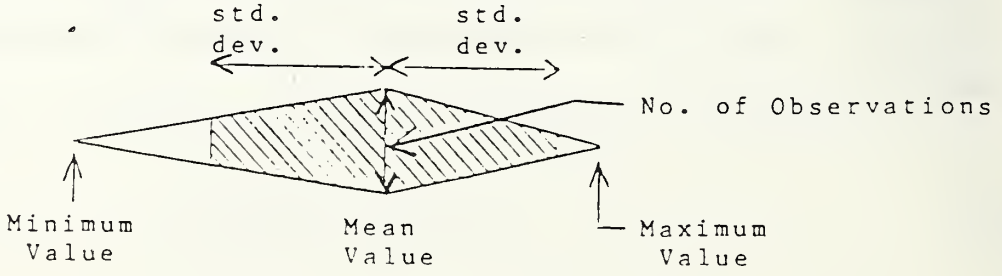
In the past, under the sponsorship of UMTA, elasticity information has been compiled (2) from studies performed in the U.S. and other countries. Hence, the real need is to integrate this information with ridership/revenue forecasting. With this view, the proposed ITPE model structure (Figure 5.1) incorporates a simple, user-interactive elasticity selector which would permit a user to view all compiled information on elasticity values in form of graphical displays. At the same time, it is envisaged that this selector will permit the user to select any elasticity value(s) of his or her choice as the input to the ridership/revenue model. The elasticity selector will be an optional module of the ITPE system because some users may already have decided on elasticity values.

Concept

The basic concept behind the design of the elasticity selector will be to convey through graphical displays all information pertaining to the observed distribution of elasticity values within each market group. Such information would provide significant guidance to the user in selecting a particular value.

In general, mean and standard deviation are two popularly utilized statistical measures used to characterize data distributions. The question is how to depict this notion in a graphical form for someone with no knowledge of statistics. Figure 5.4 illustrates one way of representing these properties in a geometrical shape. This asymmetrical diamond shape simultaneously demonstrates five properties of the frequency distribution; minimum observed value, maximum observed value, mean, standard deviation, and total number of observations. Variations in the shape of this asymmetrical diamond can visually communicate a great deal of information. For example, a narrow and high diamond (i.e., with many observations and a narrow range of data values) would suggest stability in the observed values of elasticity and hence, would give a user confidence in choosing the mean value or certain values around the mean. By using such a visual concept,all available information on the disaggregate values of fare and service elasticities can be displayed on the microcomputer screen. The user will be able to scan through these disaggregate elasticity values, then pick the sub-market of his or her choice, and finally choose the value for a particular sub-market.

Figure 5.4: Observed Elasticity Values for One Sub-Marker



Procedure

Elasticity value selection would be accomplished in the following three steps:

1. Scanning Over the Disaggregate Elasticity Values

There are almost sixty sub-markets for which observed values of fare elasticities are available. This is also true in the case of service elasticities. Hence, in this step, the user would be able to view on the microcomputer screen all values of disaggregate elasticities. For each sub-market, the distributional properties of these elasticity values will be displayed in a small asymmetrical diamond shape as discussed above.

2. Selecting a Sub-Market

Under this step, one would be able to select the sub-market of his or her interest and view an enlarged image of the chosen asymmetrical diamond shape.

3. Choosing an Elasticity Value

At this stage, the user could move the cursor along the enlarged image of the asymmetrical diamond and pick the value of his/her choice. The selected elasticity value would be treated as an input to the ridership/revenue program and stored in tabular form.

Cost Model

The Unit costs were calculated using the following:

Expense under object class "i" allocated to the asignment variable "j" and service type "r":

$$E_{ijr} = E_i * PE_i * (S_{jr} / \sum_{r \in m} S_{jr})$$

Total expense allocation to the variable "j" and service type "r":

$$E_{jr} = \sum_{i} E_{ijr}$$

Unit cost of the assignment variable for service type "r":

$$UC_{jr} = E_{jr} / S_{jr}$$

Where:

E_i = Total $ amount expense in the object class i. Increased by percentage that was input in the FUTURE INCREMENTS IN COST DATA screen.

PE_i = Proportion of base year cost under expense object class i considered for allocation.

S_{jr} = Value of assignment variable j for the service type r.

m = Subset of the service types ($m \in r$) considered under each expense class allocation.

i = Subscript representing expense object class (e.g., operators salaries, fuel and lubricants, etc.).

j = Subscript representing assignment variable (e.g., revenue hours, revenue miles, peak buses, etc.).

r = Subscript representing types of serivce (e.g., commuter, local peak, etc.).

The Total costs were calculated by the following:

Cost allocation model for service type "r":

$$TC_r = \sum_j (UC_{jr} * S_{jr})$$

Where:

UC_{jr} = Unit cost of the assignment variable j for service service type r.
(See the COMMENTS of ESTIMATED UNIT COST DISPLAY screen)

S_{jr} = Value of assignment variable j for the service type r.

Pricing Policy Evaluation Model

The pricing policy evaluation component of the ITPE model is designed to forecast the impacts of fare and/or service changes on the performance of the transit system as a whole and of individual fare or trip market segments. For this purpose, two measures of performance evaluation are estimated and displayed by the model; revenue/cost ratio and Ramsey prices. Both these measures are well known yardsticks for comparing one pricing policy with the other. Moreover they provide sufficient information to a decision maker who constantly struggles with the questions such as how high should the fare be raised, how much revenue the user should pay, and how much of the operating expenses should be paid through subsidies?

The revenue/cost ratio for the system as a whole and for each individual market segment is a good measure of the equity aspect of a fare policy. On the other hand, a comparison between the proposed (or existing) pricing structure with that of the estimated Ramsey prices demonstrates the accepted level of departure between the proposed (or existing) fare policy and an economically efficient pricing structure. Since a fare setting decision is usually an outcome of the accepted trade-offs between the equity and efficiency related objectives, estimation of these two indicators would greatly aid the fare setting process of an agency. In addition, the ITPE model will also produce other fare policy evaluation related output both at system-wide and for individual markets such as total ridership, revenue, cost per trip, and revenue per trip.

The computational procedure utilized for the above mentioned indicators are expressed below:

Estimating Revenue per Trip, Average Trip Cost and Revenue/Cost Ratio

For the estimation of revenue/cost ratio, first the annual revenue per trip is calculated for each fare/trips market segment using the outputs of the disaggregate elasticity model for

ridership/revenue forecasting (i.e., DELREV). Mathematically the procedure can be expressed as follows:

$$TRIP_{ijkm} = \{(BMR + \Delta TRIP_{rm} + \Delta TRIP_{m}^{auto}) * PBTRIP_{ijk}\} + \Delta TRIP_{ijkm} \quad (5.43)$$

$$REV_{ijkm} = [\{(BMR + \Delta TRIP_{rm} + \Delta TRIP_{m}^{auto}) * PBTRIP_{ijk}\} * FARE_{ijkm}] + (\Delta TRIP_{ijkm} * FARE_{ijkm}) \quad (5.44)$$

$$REVTRIP_{ijky} = \frac{\sum_{m} REV_{ijkm}}{\sum_{m} TRIP_{ijkm}} \quad (5.45)$$

Next, cost per trip or in other words average trip cost, for each service category is estimated. At this stage, cost data is generated using the cost allocation model developed earlier for each service category (r) as shown below:

$$TC_{ry} = \sum_{l} UC_{lry} * S_{lry} \quad (5.46)$$

$$AC_{ijky} = \frac{TC_{ry}}{TRIP_{ijky}} \quad (5.47)$$

Finally, the revenue/cost ratios (popularly known as the recovery ratio) are calculated by dividing the average revenue per trip of each market segment and average trip cost of the service category corresponding to (or serving) that particular market segment (ijk).

$$RATIO_{ijky} = \frac{REV_{ijky}}{AC_{ry}} \quad (5.48)$$

where;

BMR	=	Base month ridership
ΔTRIP	=	Change in ridership
PBTRIP	=	Percentage of BMR
REV	=	Total fare revenue
FARE	=	Fare level
REVTRIP	=	Average revenue per trip
TC	=	Total operating cost
UC_{lry}	=	Unit cost of the assignment variable l for service type r during year y
S_{lry}	=	Value of assignment variable l for service type r during year y
AC	=	Average trip cost
RATIO	=	Ratio of revenue per trip and average trip cost
i,j,k	=	Subscript representing fare categories
l,r	=	Subscript representing expense assignment variables l and service types r respectively

Ramsey Pricing

The marginal-cost pricing rule is well known in the business world, where managers target for higher profits (3,4). However, for public agencies and regulated industries, a variation of this rule called Ramsey or the inverse elasticity rule is generally advocated by economists. According to this rule for attaining the greatest benefit to consumers within a budget constraint, an agency should set prices (fares) in a way that percentage deviations of prices (or fares) from marginal costs are proportional to the inverse of the price (or fare) elasticies of demand.

The program will allow the user to input marginal cost for each service type. If marginal cost is not input for a particular category the program will use the average trip cost calculated earlier (AC_{ry}) as the marginal cost. In this case, the Ramsey rule can be expressed as follows:

$$\frac{E_{ij1}(BFARE_{ij1} - AC_{ry})}{BFARE_{ij1}} = \frac{E_{ij2}(BFARE_{ij2} - AC_{ry})}{BFARE_{ij2}} = \ldots$$

$$= \frac{E_{ijk}(BFARE_{ijk} - AC_{ry})}{BFARE_{ijk}} = K \qquad (5.49)$$

The data required for the calculation of Ramsey prices are taken from DELREV (e.g., elasticities and base fare for each market segment) and the cost model components of ITPE. The computational procedure begins by calculating first the total profit (or loss) from all market segments during a particular year (y) for the given base fare and ridership level as follows:

$$SUMP_y = \sum_i \sum_j \sum_k BTRIP_{ijlk}(BFARE_{ijk} - AC_{ry}) \qquad (5.50)$$

The algorithm starts an interactive process by setting first a very low fare for the first market segment and a variable SUM equal to zero. The Ramsey Constant (k) is then calculated for the first market segment and time period. Using the Ramsey Constant, the elasticities, and average costs, new fares and ridership (using mid-point elasticity equation 9) are computed for all market segments in a way that will satisfy equation 7.

$$TRIP^1_{ijk} = BTRIP_{ijk} * \frac{1 + 2 * E_{ijk} * (FARE^1_{ijk} - BFARE_{ijk})}{FARE^1_{ijk} * (1 - E_{ijk}) + BFARE_{ijk} * (1 + E_{ijk})} \qquad (5.51)$$

The new fares ($FARE^{1}_{ijk}$) and demand levels ($TRIP^{1}_{ijk}$) determine new profit (or loss) levels which are added to SUM. When all profits (or losses) are added, SUM is compared with the initial total profit (or loss), SUMP. The interation continues by slightly increasing the fare for the first market and repeating above calculations until the current profit or loss (SUM) becomes at least equal to the original one (SUMP). As soon as this happens, the fares of all market segments are printed out.

This component of ITPE will include an additional feature that will permit a model user to set the upper or lower limit for a particular market or several markets. This feature is especially meant for those fare groups which are generally subsidized (e.g., elderly, handicapped and students).

References:

(1) Mayworm P., Lago A.M., Transit Fare Prepayment: A Guide for Transit Managers, Urban Mass Transportation Admin., Washington, D.C., January, 1983.

(2) Mayworm P., Lago A.M., McEnroe M.J., Patronage Impacts of Changes in Transit Fares and Services, Urban Mass Transportation Admin., Washington, D.C., September, 1980.

(3) Baumol W., Bradford D., Optimal Departures from Marginal Cost Pricing, American Economic Review, Vol. 60, June, 1970.

(4) Bladikas A.K., Crowell N.H., Pricing Options for Urban Transportation Modes, Urban Mass Transportation Admin., Washington, D.C., August, 1984.

APPENDICES

APPENDIX A

ALTERNATIVE INSTALLATIONS:

The ITPE program does not require a 2 floppy system to run. It can also be set up on a hard disk, a 1 floppy system, or even a RAMdisk which speeds up the program considerably.

USING A HARD DISK

1) Insert the ITPE program disk in drive A:
2) Type: A:HARDINST, then press RETURN. (HARDINST will create a subdirectory on you hard disk called: \ITPE, and will also create a batch file in you root directory called: ITPE.BAT)
3) Type: ITPE C: to run the ITPE program.

USING 1 FLOPPY OR A RAM DISK

1) Create a SYSTEM diskette by formatting a diskette with the command: FORMAT/S
2) Copy the CONFIG.SYS and AUTOEXEC.BAT files from the ITPE program disk to that SYSTEM diskette.
3) Copy the VDISK.SYS file from your DOS disk to that SYSTEM diskette.

Now, to run the ITPE program:

1) Insert the SYSTEM disk and press the CTRL-ALT-DEL keys.
2) You will be instructed to type in a couple of commands which will copy the ITPE files to the RAMDISK and execute the program.
3) Next, you are asked for the letter of the drive that the data files are on. You can either type in the letter of your hard disk or floppy. In either case, you can remove the ITPE program disk from drive A:

NOTE1: You will need 640K when using the RAM disk configuration and you may run out of memory if your model is too large in which case you should use the hard disk or 2 floppy configuration.

NOTE2: You may wish to modify the AUTOEXEC.BAT file on your SYSTEM disk so that you don't have to type RUNITPE command. For example, if your RAMdisk was the D: drive, then your AUTOEXEC.BAT file would look like:

```
echo off
echo Insert your program disk in drive A:
pause
A:RUNITPE D
```

APPENDIX B

DATA ENTRY:

Entering data is very straightforward in that you simply type in the data into a field. For a deeper understanding, however, I will explain the ITPE data entry in detail.

There are 3 types of fields: TEXT, NUMERIC, & DATE. All 3 fields share the following features:

1) As soon as you press a key when the cursor is in the 1st character position of a field, that field is blanked out and the format and length of the field is shown. For example, a numeric field may be shown as ___.__ , in which case the largest number you can input is 999.99.
2) When you type a valid key, the character appears and the cursor moves right one space unless the cursor is at the last position.
3) When you type a backspace key, the character to the left is deleted and the cursor moves to that spot.
4) Pressing RETURN,ESC, or an arrow key will format the value just entered.
5) No spaces are allowed.

The differences of the 3 fields are:

FORMATTING:

TEXT - The text entered is left justified.
NUMERIC - The number entered is right justified.
DATE - If the date is invalid, then the field is blanked.

VALID INPUT:

TEXT - Basically any text such as numbers, letters, & punctuation marks.
NUMERIC - 0-9, . (if a real number), - (if negative # allowed).
For real numbers, you can type in the number directly without having to enter leading 0's. For example, to enter a 1.5 in a field with the format ____.__, you would just type 1.5 then press RETURN.
DATE - 0-9 and you must enter leading 0's for the days and months with the # 1-9.

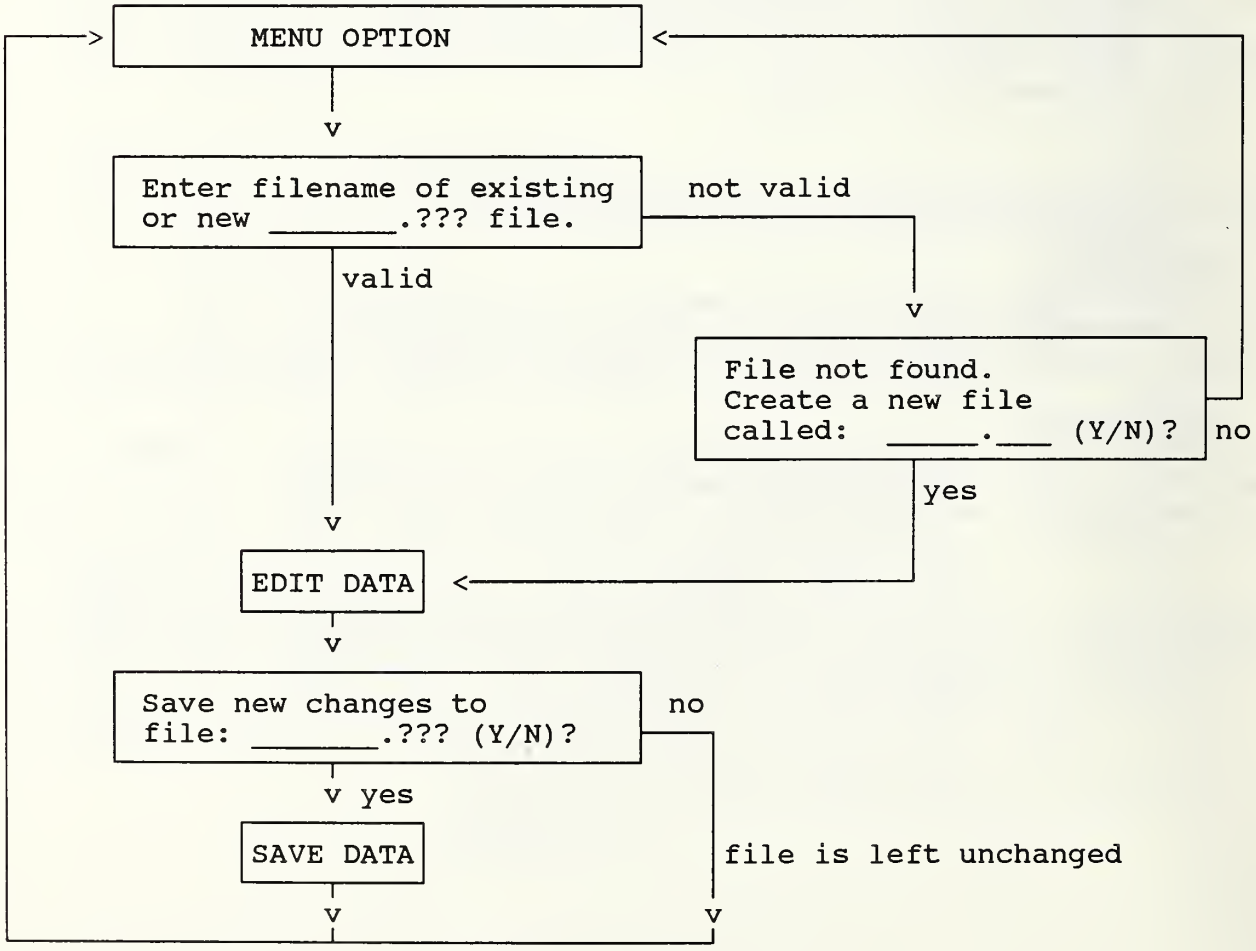
APPENDIX C

INPUT DATA FILES:

The ITPE program stores its INPUT data in 7 different files each having a unique filename extension:

1. ????????.CST : COST INPUT
2. ????????.FR1 : FARE INPUT
3. ????????.FR2 : FARE CATEGORY NAMES & BASE DATA INPUT
4. ????????.SR1 : SERVICE INPUT
5. ????????.SR2 : SERVICE CATEGORY NAMES & BASE DATA INPUT
6. ????????.AUT : AUTO COST FORECAST INPUT
7. ????????.CST : CPI & NOMINAL GROWTH INPUT

Throughout the program, however, you will be treating files 2&3 as one file and 4&5 as another. The program just stores them physically in seperate files. Therefore, there are actually only 5 types of data files. All input file prompts work the following way:



APPENDIX D

SETTING UP SCENARIOS:

When outputting reports, you are prompted for the filenames of 4 input data files. This allows the flexibility of trying different scenarios. For example, if you have two FARE data files that use the same SERVICE, AUTO COST,and CPI data, you only have to create two FARE data files. Then you can output the report once with the first FARE file and again with the second FARE file.

You could perhaps have several FARE,SERVICE,AUTO COST, and CPI files and use combinations of the 4 input data files when outputting your reports.

If you need to create a data file that is very similiar to another data file, then the easiest way is to first use the DOS copy command to copy the file to another file with a new filename (make sure that the extension is the same for both files). Then just modify the data from that new file.

APPENDIX E

Derivation of Equation (5.15)

$$ATRIPS_{pm} = BATRIPS_p + \frac{0.70\ (BKEVEN_m^2 - BBKEVEN^2)}{6096 + 0.70\ (BBKEVEN + BKEVEN_m)^2}$$

This equation is obtained from the following regression equation which was developed using the data of monthly trip rates and break-even rates observed during several periods of time in Seattle, Washington.

$$ATRIPS_p^2 = 1524 + 0.70\ BKEVEN^2$$

$$ATRIPS_p = (1524 + 0.70\ BKEVEN^2)$$

Taking the derivative of this equation;

$$\frac{ATRIPS_p}{BKEVEN} = 0.5\ (1524 + 0.70\ BKEVEN^2)^{-1/2} * (2)(0.70)\ (BKEVEN)$$

$$\frac{ATRIPS_p}{BKEVEN} = \frac{0.70\ BKEVEN}{1524 + 0.70\ BKEVEN^2}$$

As we are interested with finite changes in the break-even rate:

$$ATRIPS_p = ATRIPS_{pm} - BATRIPS_p$$

$$BKEVEN_m = BKEVEN_m - BBKEVEN$$

$$BKEVEN = (BBKEVEN + BKEVEN_m) / 2$$

Thus,

$$ATRIPS_{pm} = BTRIPS_p + \frac{0.70\ (BKEVEN_m^2 - BBKEVEN^2)}{6096 + 0.70\ (BBKEVEN + BKEVEN)^2}$$

Derivation of Equation (5.16)

$$PTRIPS_{pm} = BPTRIPS_p * [1 + (0.0597)\ (1-BPTRIPS_p)\ (DISC_{pm})]$$

Recall Equation (5.25) and (5.26)

$$PTRIPS_{pm} = e_m^u / (1 + e_m^u)$$

Taking partial derivative of this equation with respect to $DISC_{pm}$;

$$\frac{PTRIPS_{pj}}{DISC_{pj}} = (1 + e_m^u)^{-1} * (e_m^u)\ (u_m / DISC_{pm}) + (e_m^u)\ (-1)\ (1+e_m^u)^{-2}\ (e_m^u)\ (u_m / DISC_{pm})$$

$$\frac{PTRIPS_{pm}}{DISC_{pm}} = (PTRIPS_{pm})\ (u_m / DISC_{pm}) + (PTRIPS_{pm})^2\ (u_m / DISC_{pm})$$

$$= (PTRIPS_{pm})\ (u_m / DISC_{pm}) + (1 - PTRIPS_{pm})$$

since;

$$PTRIPS_{pm} = PTRIPS_{pm} - BPTRIPS_p$$

$$DISC = DISC_{pm} - BDISC_p = DISC$$

MoreoverA

$$\frac{u}{DISC} = 0.0597$$

Therefore;

$$\frac{PTRIPS_{pm} - BPTRIPS_p}{DISC} = (PTRIPS_{pm})\ (0.0597)\ (1-PTRIPS_{pm})$$

$$PTRIPS_{pm} = BPTRIPS_p \times [1 + (0.0597)\ (1 - BPTRIPS_p)\ (DISC)]$$

Derivation of Equation (5.17)

$$DIVTRIPS_{pm} = \frac{GSTRIPS_m * PTRIPS_{pm}}{2-(E_p) * (DISC/(100-BDISC_p)\ (1-PTRIPS_{pm})} - BTRIPS_p$$

Above equation is derived from the following equations:

$$TRIPS_{pm} = (GSTRIPS_m + NTRIPS_{pm}) \times PTRIPS_{pm} \quad (a)$$

$$TRIPS_{pm} = BTRIPS_p + NTRIPS_{pm} + DIVTRIPS_{pm} \quad (b)$$

$$NTRIPS_{pm} = (BTRIPS_p + DIVTRIPS_{pm})(E_p)(DISC/(100-BDISC_p) \quad (c)$$

(for derivation see Equation (5.18)

Using (a) and (b)

$$BTRIPS_p + NTRIPS_{pm} + DIVTRIPS_{pm} =$$

$$GSTRIPS_m * PTRIPS_{pm} + NTRIPS_{pm} * PTRIPS_{pm}$$

$$(DIVTRIPS_{pm} + BTRIPS_p) + (NTRIPS)(1-PTRIPS_{pm}) =$$

$$GSTRIPS_m * PTRIPS_{pm}$$

Substituting (c):

$$(DIVTRIPS_{pm} + BTRIPS_p)\ [1 - (E_p)(\ DISC/(100-BDISC_p)(1-PTRIPS_{pm})]$$

$$= GSTRIPS_m * PTRIPS_{pm}$$

$$DIVTRIPS_{pm} = \frac{GSTRIPS_m * PTRIPS_{pm}}{1-(E_p) * (\ DISC/(100-BDISC_p)\ (1-PTRIPS_{pm})} - BTRIPS_p$$

Derivation of Equation (5.18)

$$NTRIPS_{pm} = -(BTRIPS_p + DIVTRIPS_{pm})\ (E_p)\ (\ DISC_{pm}/(100-BDISC_p))$$

Before average fare F_1 =

$$\frac{(BFARE_p/ATRIPS_p)\ (BTRIPS_p) + AFARE_m * DIVTRIPS_{pm}}{BTRIPS_p * DIVTRIPS_{pm}}$$

After average fare $F_2 = FARE_{pm}/ATRIPS_{pm}$

Before pass trips $Q_1 = BTRIPS_p + DIVTRIPS_{pm}$

After pass trips $Q_2 = TRIPS_{pm}$

$$Q_2 - Q_1 = NTRIPS_{pm}$$

According to elasticity definition;

$$Q = Q_2 - Q_1 = (Q_1)\ (E_p)\ [(F_2 - F_1)/F_1]$$

Assuming $DIVTRIP_{pm}$ is small relative to the total pass trips. In this situation, $DIVTRIP_{pm} = 0$.

$$\frac{(F_2-F_1)}{F_1} = \frac{(FARE_{pm}/ATRIPS_{pm})*(BTRIP_p) - (BFARE_p/ATRIPS_p)(BTRIPS_p)}{(BFARE_p/ATRIPS_p)\ (BTRIPS_p)}$$

$$\frac{(F_2-F_1)}{F_1} = \frac{(FARE_{pm}/ATRIPS_{pm}) - (BFARE_p/ATRIPS_p)}{(BFARE_p/ATRIPS_p)}$$

However;

$$BDISC_p/100 = \frac{AFARE - (BFARE_p/ATRIP_p)}{AFARE}$$

$$DISC_{pm}/100 = \frac{AFARE_m - (FARE_{pm}/ATRIP_{pm})}{AFARE_m}$$

or;

$$BFARE_p/ATRIP_p = AFARE\ (1 - (BDISC_p/100))$$

$$FARE_{pm}/ATRIP_{pm} = AFARE_m\ (1 - (DISC_{pm}/100))$$

By substituting;

$$\frac{F_2-F_1}{F_1} = \frac{BDISC_p - DISC_{pm}}{100 - BDISC_p}$$

$$= - DISC_{pm}/(100-BDISC_p)$$

Returning to elasticity definition:

$$NTRIPS_{pm} = (BTRIPS_p + DIVTRIPS_{pm})\ (E_p)\ (-\ DISC_{pm}/(100-BDISC_p))$$

Derivation of Equation (5.20)

$$DIVTRIPS_{pm} = BTRIPS_p\ [1-(E_p)(\ DISC/(100-BDISC_p)(1-PTRIPS_{pm})] -$$
$$(GSTRIPS_m)(PTRIPS_{pm})$$

Above Equation can be derived from the following equations;

$$TRIPS_{pm} = (GSTRIPS_m - LTRIPS_{pm})\ (PTRIPS_{pm}) \qquad (a)$$

$$TRIPS_{pm} = BTRIPS_p - DIVTRIPS_{pm} - LTRIPS_{pm} \qquad (b)$$

$$LTRIPS = (BTRIPS_p)\ (E_p)\ [\ DISC_{pm}/(100-BDISC_p)] \qquad (c)$$

Substituting (b) in (a):

$$BTRIPS_p - DIVTRIPS_{pm} - (GSTRIPS_m)(PTRIPS_{pm}) = (LTRIPS_{pm})(1-PTRIPS_{pm})$$

Substituting (c) and solving:

$$DIVTRIPS_{pm} = BTRIPS_p \left[1-(E_p)\left(DISC/(100-BDISC_p)\right)(1-PTRIPS_{pm})\right] - (GSTRIPS_m)(PTRIPS_{pm})$$

Derivation of Equation (5.27), i.e., Estimation of Diverted Trips

$$LIVTRIPS_{pm} = \frac{GSTRIP_m * PTRIPS_{pm}}{1-E_p\ (DISC_{pm}/100)\ (1-PTRIPS_{pm})} \qquad (5.16)$$

This equation is derived from the following four equations.

$$TRIPS_{pm} = TRIPS_m * PTRIPS_{pm} \qquad (a)$$

$$TRIPS_{pm} = DIVTRIPS_{pm} + NTRIPS_{pm} \qquad (b)$$

$$TRIPS_m = GSTRIPS_m + NTRIPS_{pm} \qquad (c)$$

$$NTRIPS_{pm} = -(DIVTRIPS_{pm}) * E_p * (DISC_{pm}/100) \qquad (d)$$

From (a) and (b):

$$DIVTRIPS_{pm} + NTRIPS_{pm} = TRIPS_m * PTRIPS_{pm}$$

Substituting (c):

$$DIVTRIPS_{pm} + NTRIPS_{pm} = GSTRIPS_m * PTRIPS_{pm} + NTRIPS_{pm} * PTRIPS_{pm}$$

$$DIVTRIPS_{pm} + NTRIPS_{pm}\ (1- PTRIPS_{pm}) = GSTRIPS_m + PTRIPS_{pm}$$

Substituting (d):

$$DIVTRIPS_{pm} - DIVTRIPS_{pm} * E_p\ (DISC_{pm}/100)\ (1-PTRIPS_{pm}) = GSTRIPS_m * PTRIP_{pm}$$

$$DIVTRIPS_{pm}\ [1-E_p * (DISC_{pm}/100)\ (1-PTRIPS_{pm})] = GSTRIPS_m * PTRIPS_{pm}$$

$$DIVTRIPS_{pm} = \frac{GSTRIPS_m * PTRIPS_{pm}}{1-E_p\ (DISC_{pm}/100)\ (1-PTRIPS_{pm})}$$

APPENDIX F

Determination Of Weighting Factors

Weighting Factors are figures that expand the survey sample to the population of riders. Because it is not feasible to survey all the riders on a particular transit route, a representative sample is instead taken. The question is, how can the sample be made representative of the total number of riders. Weighting Factors provide an answer.

The following example will demonstrate how these factors are determined. Suppose that an on-board survey was taken on one day on one route and you managed to collect responses from 60 riders. Of these riders, 25 make 5 trips per week, 20 make 3 trips per week, and 15 make 1 trip per week. You want to know to what degree each respondent represents the total ridership on that route. You also know that a total of 1800 trips per week are taken on that route. (Be sure not to confuse the number of trips with the number of riders, as some riders make more trips than others). Since some riders take 5 trips per week on this route, your chances of surveying them are greater than your chances of surveying the riders making fewer trips/week. Thus, the riders making more trips per week must be weighted less than the riders making fewer trips per week.

The equation for determining the correct weighting factor for each rider is the following:

$$\frac{\text{[Total number of trips per period on route]}}{\text{[Number of survey forms collected from that route]}} \times \frac{1}{\text{Number of trips per period for that rider}}$$

Substituting the numbers from our example, the weighting factors for each type of rider would be:

$$\frac{1800}{60} \times \frac{1}{5} = 6.0 \text{ for those taking 5 trips per period}$$

$$\frac{1800}{65} \times \frac{1}{3} = 10.0 \text{ for those taking 3 trips per period}$$

$$\frac{1800}{65} \times \frac{1}{1} = 30.0 \text{ for those taking 1 trip per period}$$

This can be checked by summing over all forms (not trips) the number of trips per week for each rider multipled by the weighting factor for each rider.

$$\text{All forms} \quad \text{(Trips per Period x Weighting Factor)}$$

Substituting our figures, we arrive at:

$$25 \times 5 \times 6.0 = 750$$

$$20 \times 3 \times 10.0 = 600$$

$$15 \times 1 \times 30.0 = 450$$

1800 trips per week

This process is repeated for each route, and each route would typically have a different set of weighting factors.